MOVEMENT PATTERNS OF STREAM-RESIDENT SNAKE RIVER AND YELLOWSTONE CUTTHROAT TROUT

2001-2002 Radio Telemetry Project

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ABSTRACT

Radio telemetry was used to assess mobility of cutthroat trout in the Snake River headwaters of Wyoming from July 2001 to August 2002. Four adult Yellowstone cutthroat trout *Oncorhynchus clarki bouvieri* and sixty-three adult finespotted Snake River cutthroat trout *O. c.* subsp. were surgically implanted with one of three sizes of radio transmitter (3.8 gm, 100 d life cycle; 6.8 gm, 35 d life cycle; 10.9 gm 283 d). A pattern of summer-fall (median 0-50 m; range 0-6,000 m) and winter-spring (median 0-250 m; range 0-800 m) movements was observed. In late-fall, twelve fish exhibited a single movement (range 250-2000 m) from a summer-fall range to a winter-spring range. In late-spring, five fish exhibited two distinct movements (range 1,000-4,800 m) after the winter-spring season and prior to establishing summer-fall ranges. We found cutthroat trout displayed two distinct patterns of mobility: 1) Median summer-fall movements were smaller than winter-spring movements, however, summer-fall ranges were larger than winter-spring ranges; and 2) Some fish exhibit fall migrations possibly in search of over-winter habitat, and spring migrations either seeking refuge from high spring flows or to spawn.

EXECUTIVE SUMMARY

Our project was conducted to investigate the movement patterns of stream resident Yellow stone cutthroat trout *Oncorhynchus clarki bouvieri* (YSC) and finespotted Snake River cutthroat trout *O. c.* subsp. (SRC) within the Snake River headwaters of northwest Wyoming. This report describes our methods, observations, and results, and movement patterns displayed during the study. Our goal was to conduct a pilot study of cutthroat trout movements using radio telemetry. Objectives were: 1) Obtain internal-antennae radio transmitters, and receivers, and conduct a pilot telemetry study during 2001-2002; 2) Implant transmitters in approximately 35 cutthroat trout each, in the Gros Ventre River and Greys River drainages; 3) Capture fish for transmitter implantation in spawning tributaries, after completion of spawning, during early July 2001; 4) Monitor fish movements in each drainage by driving roads to obtain general locations and walking streams for more exact locations, twice-weekly from early July through October, 2001, and at least monthly during the winter 2001-2002. Monthly flights were to be used to determine general stream locations in the event that fish could not be located by driving roads adjacent to the streams.

Sixty-three Snake River cutthroat trout and four Yellowstone cutthroat trout were captured and surgically implanted with radio transmitters in mid to late-July 2001. Given that so few YSC were captured no distinction is made between SRC and YSC movements. We used telemetry relocations to determine the weekly, monthly, seasonal, and annual movements of each cutthroat trout. We defined ranging behavior based on observed movements as: a fall or spring *migration*, *total* or *annual range*, and *seasonal range*.

Overall, the telemetry project proved to be highly successful. Mortalities during and following surgery were minimal, and data collection improved over time. Radio telemetry was proved to be a very effective method to determine cutthroat trout ranging behavior, and we gained previously unconfirmed insights into seasonal migrations in headwater tributaries of the Snake River in Wyoming. Another important observation was that mean movements (or average value) tend to be heavily skewed by a few fish exhibiting large or small ranging movements, and therefore, median movements (the "middle" value in a set of movements arranged from shortest to longest) appear to be the most informative.

Overall, cutthroat trout in the Greys R and Gros Ventre R drainages exhibited similar weekly, seasonal, and annual patterns of movement. Ranging movements were less than <500 m for the majority of fish, with many remaining in the same habitat unit throughout the duration of the transmitters' life. However, all of those 46 fish were either implanted with radio transmitters that expired during fall 2001 or winter 2002 or the fish died, and could not be relocated for an entire year. Thus, it is uncertain whether all of the 46 represent local resident fish. We observed migrations between summer-fall and winter-spring seasons, and all of the fish with active transmitters into the 2002 spring season performed two distinct spring migrations. Ranging behavior observed in the two river drainages suggests an admixture of life histories, including local stream residents and fluvial migrants. The latter utilizing various habitats within connected streams, over a length of 1000 m to 5000 m, for summer feeding with favorable growth conditions, over-winter refugia from harsh environmental conditions, and spring spawning and egg incubation. In some cases these fish were able to locate habitats favorable for both summer and winter seasons within the same stream reach.

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INTRODUCTION

Over the past fifty years, there have been many studies conducted to examine the movement patterns of stream resident fishes within high elevation streams. Many conclusions, theories, and paradigms have emerged from these studies to explain fish movement patterns. Our project was conducted to investigate the movement patterns of stream resident Yellow stone cutthroat trout *Oncorhynchus clarki bouvieri* (YSC) and finespotted Snake River cutthroat trout *O. c.* subsp. (SRC) within the Snake River headwaters of northwest Wyoming. This project was not intended to support or refute prior studies. Our intent was to describe our methods, observations, and results, and movement patterns displayed during the study. Our goal was to conduct a pilot study of cutthroat trout movements using radio telemetry. Objectives were: 1) Obtain internal-antennae radio transmitters and receivers, and conduct a pilot telemetry study during 2001-2002; 2) Implant transmitters in approximately 35 cutthroat trout each, in the Gros Ventre River and Greys River drainages; 3) Capture fish for transmitter implantation in spawning tributaries, after completion of spawning, during early July 2001; 4) Monitor fish movements in each drainage by driving roads to obtain general locations and walking streams for more exact locations, twice-weekly from early July through October, 2001, and at least monthly during the winter 2001-2002. Monthly flights were to be used to determine general stream locations in the event that fish could not be located by driving roads adjacent to the streams.

Assumptions prior to beginning the project were as follows: 1) Concentrations of spawning-age YSC and SRC are comprised of locally resident (e.g., stream reach) and non-resident fish; 2) Cutthroat trout > 250 mm TL captured in or near known spawning concentrations are adults ($\geq$age III) and may be either locally resident or non-resident fish; 3) Non-resident post spawning fish will be mobile, moving to nearby stream reaches or streams during the summer or fall; 4) Movement of fish will be indicative of their life history (e.g., resident or fluvial migrants); 5) Movement and mobility information will aid in identification of life history diversity of YSC and SRC.; and 6) In combination with recently completed cutthroat trout distribution surveys, and proposed research addressing geographic subdivision in YSC and SRC, direct observation of ranging behavior would provide supporting data for identification of spatial population structure.

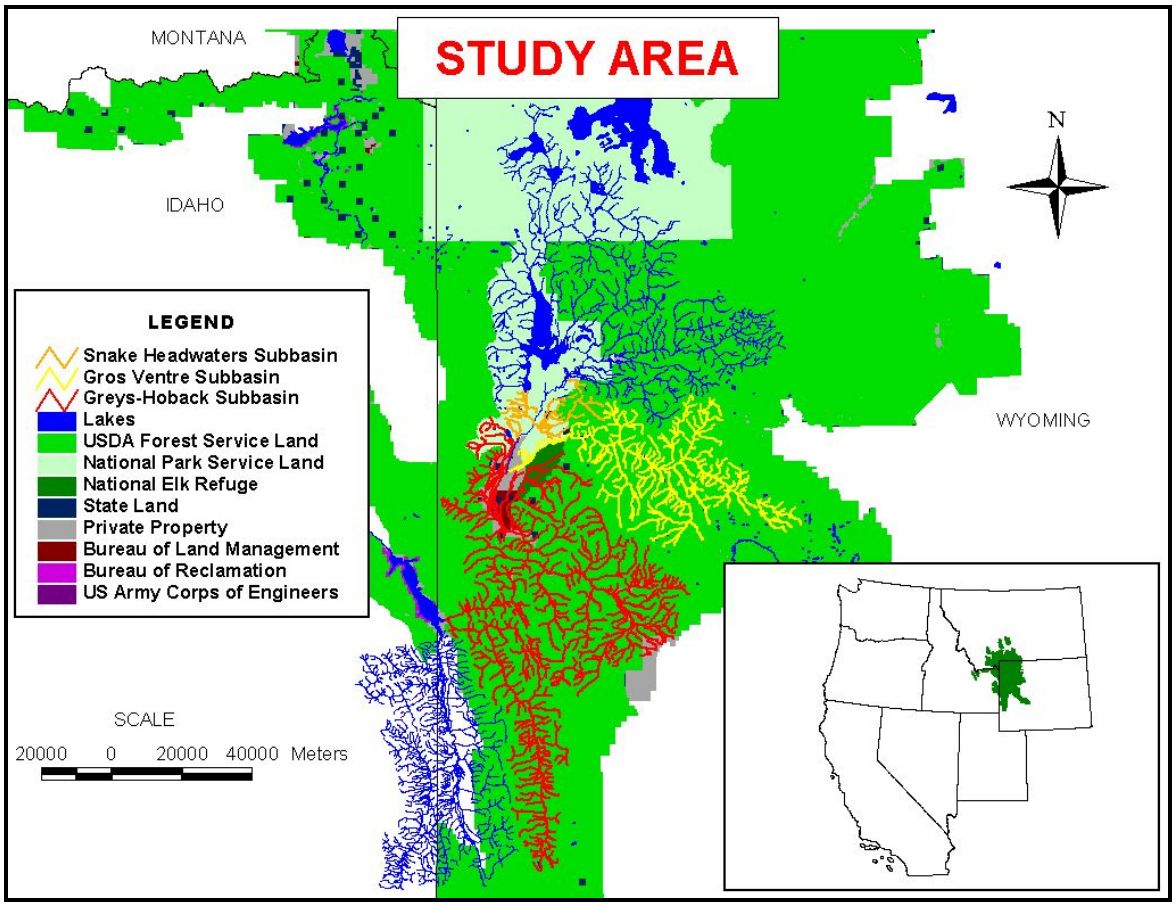


Figure 1. Major river drainages in the Snake River headwaters of the northwest Wyoming.

This report describes weekly, seasonal, and annual movements based on telemetry locations of adult YSC and SRC in the Gros Ventre River and Greys River drainages (Fig. 1). The results from this project are intended to provide fisheries and natural resource managers a greater understanding of cutthroat trout mobility within the Snake River headwaters of Wyoming, and allow for more informed decisions regarding native cutthroat trout.

STUDY AREAS

Cutthroat trout movements were studied in the Gros Ventre and Greys River drainages within the Bridger-Teton National Forest in northwest Wyoming (Fig. 1). Transmitters were surgically implanted in cutthroat trout captured in the Little Greys River and Steer Creek in the Greys River drainage. In the Gros Ventre River drainage fish were captured in Fish Creek, North Fork Fish Creek, and South Fork Fish Creek.

Tracking within the Little Greys R drainage proved to be much easier than in the Fish Cr drainage due to the close proximity of the road and stream. While stream and valley characteristics were similar in the two areas, there were some major differences as well. The Fish Creek drainage is located approximately 70 km northeast of the Little Greys River drainage study area. The Fish Cr drainage is over 300 m higher in elevation and receives a higher annual snowfall as well. Also, Fish Cr drainage water temperatures and flow declines occurred one to two weeks earlier in the summer-fall season 2001, and spring run-off arrived later in the winter-spring season 2002.

Greys River Drainage

Fish within the Greys River study area (Fig. 2) were captured and tagged in the Little Greys River 14,000 to 26,000 m upstream of the confluence with the Greys River, and in Steer Creek between 0 and 3,000 m. Riparian communities along both streams are dominantly willow and conifer. The Little Greys River is moderately confined between 14,000 and 20,000 m, and unconfined from 22,000 to 26,000 m. Steer Cr is unconfined up to 3,000 m. Aquatic habitat complexity is low in each stream, and dominated by low-gradient rifle and lateral scour pools. Riparian and aquatic habitat is moderately degraded along both streams. A gravel surface road provides access throughout the study area, and periodically encroaches upon both stream channels. The Little Greys River drainage receives high recreational use during the summer and fall months. Many anglers fish the Little Greys River during the summer months, and numerous dispersed camping sites are near or immediately adjacent to the stream. The entire project area is within the Little Greys Cattle and Horse Allotment, and riparian areas were intensively grazed.

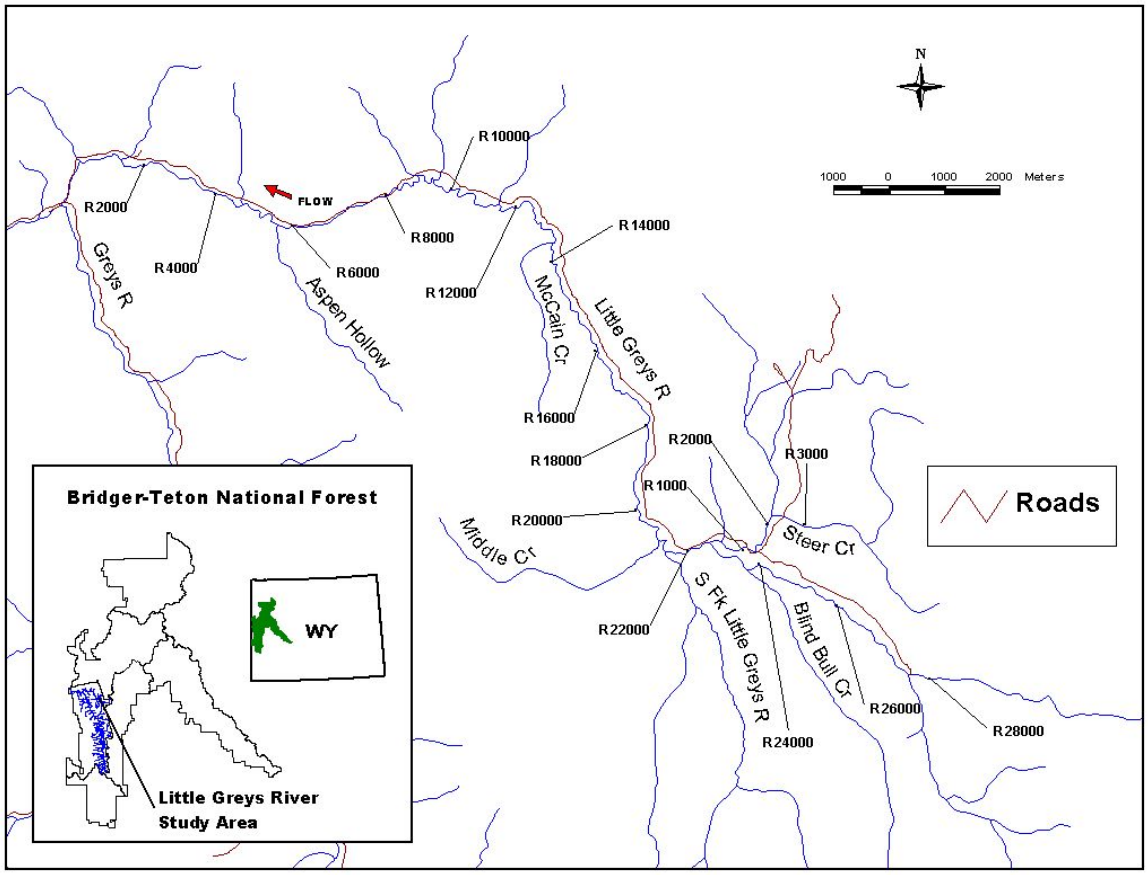


Figure 2. Little Greys River and Steer Creek study area, in the Greys River drainage.

Gros Ventre River Drainage

In the Gros Ventre R drainage study area (Fig.3) fish were captured and tagged between 0 and 2,000 m, and 12,000 to 16,000 m of the N Fk Fish Cr; 0 to 2,000 m of S Fk Fish Cr; and 4,000 to 6,000 m of Fish Cr. The Gros Ventre study area was divided into two sub-areas, one in the upper N Fk Fish Cr drainage (12,000-16,000 m) and the vicinity of the confluence N and S Fk's of Fish Cr (0-2,000 m N Fk Fish Cr; 0-2,000 m S Fk Fish Cr; and 4,000-6000 m Fish Cr). This was necessary given the logistical constraints of accessing each area by separate Forest roads from the north and south at different times, to conduct relocations. Riparian vegetation along all three streams is dominated by willow-grass communities, and the streams are moderate to unconfined. Aquatic habitat complexity is low in the sub-areas and dominantly low-gradient rifle and lateral scour pools. Riparian and aquatic habitats in the immediate vicinity of the study

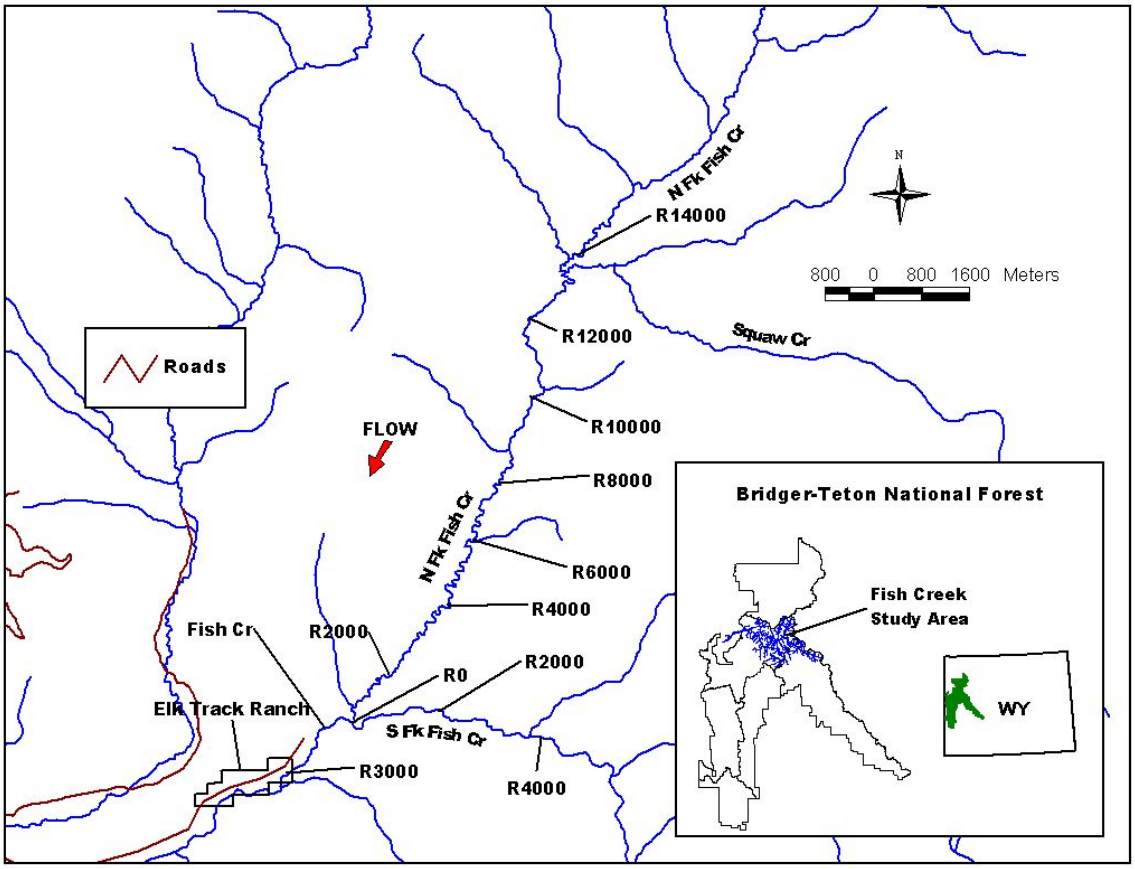


Figure 3. Fish Creek, North Fork Fish Creek, and South Fork Fish Creek study area, in the Gros Ventre River drainage.

areas have been subjected to less degradation as compared to the Little Greys R drainage mainly due to a lack of road access. However, timber harvest and associated road construction have impacted much of the upper watersheds of both the N and S Fk's Fish Cr, and both watersheds are grazed by permitted livestock. Forest trails lead into and run parallel with each of the streams. The owners and ranch manager of the Elk Track Ranch were extremely gracious and cooperative in allowing our crews access through their property to relocate fish in the vicinity of the N and S Fk Fish Cr confluence.

METHODS

Sixty-seven radio transmitters were surgically implanted into sixty-three SRC and four YSC in mid-July 2001. Cutthroat trout were captured by three-person electrofishing crews working up- and down-stream of a surgery site. Fish were kept in holding tanks prior to surgery, anesthetized with MS-222, and each fish was photographed and a fin clip taken. Total length (TL; mm) and weight (gm) was recorded prior to surgery, and transmitters implanted in the pelvic girdle of each fish. Incisions were closed with a veterinary suture and sterilized with iodine solution, and fish were placed in a recovery tank for approximately one-half hour before release back into the stream. The surgical procedure averaged less than 4 minutes per fish. Release sites were geo-referenced with a hand-held Trimble GPS unit. The fish were allowed to acclimate for approximately one week post-surgery before locations began. Metadata for surgery and locations are given in Appendix A.

Three sizes of internal-antennae transmitters were used, each with a 3.0 v signal strength. The manufacturer's (Advance Telemetry Systems) guaranteed transmitter life varied by type of battery and programming and were: 3.8 gm - 100 day; 6.8 gm - 35 day; and 10.9 gm - 283 day. Only the 283-d transmitters were programmed to cycle on/off MON-FRI between 0800-1800 h, and emit a mortality signal after 8 h without movement. Tracking began during the last week of July 2001, with each fish being located once each week until November, when winter conditions prohibited vehicle access. The fish were located once each month from January to March by accessing the study areas on snow machine and skiing along the stream, then on a bi-weekly basis from May to August of 2002. No locations were recorded during December 2001 and April 2002. Also, one aerial location was performed on May16, 2002 for fish we were unable to locate by vehicle or on foot.

A written description was recorded for each location date, along with marking the location on a 7.5 minute topographic map. Each relocation position was geo-referenced, and a listing of stream reach, water temperature and time recorded. Gain and power of the transmitter signal were recorded, and a written description of the specific habitat unit the fish occupied was recorded and delineated on a 7.5 topographic minute map. The receiver (Lotek SRX400A, W9 Firmware) was able to confirm locations within 1 m^2. Once a location was confirmed, the fish was disturbed to verify no mortality and movement was confirmed with a second telemetry location.

Thirty-one transmitters were implanted in fish from the Little Greys River and Steer Creek. Twelve fish 200-325 gm received 100 d transmitters, nine 325-525 gm fish were surgically implanted with 35 d transmitters, and ten fish >525 gm received a 283 d transmitter. Locations for the Little Greys R drainage study area were recorded from 08/03/2001 - 11/08/2001 during the first summer-fall season, 01/26/2002 - 06/14/2002 for the winter-spring season, and 06/20/2002 - 08/04/2002 for the second summer-fall season.

Tracking the fish within the Little Greys River drainage occurred without any major disruptions. The road running parallel with the Little Greys River made travel and recording locations very easy. Locating fish in the Little Greys River involved scanning the river from the road with the truck-mounted antenna. The vehicle was stopped every 500-1000 m, and the receiver scanned through all the known frequencies within the drainage with engine off to avoid interference with signal reception. When a fish was located from the road it was tracked to the habitat unit occupied with the hand held antenna, and data was then collected.

Thirty-six transmitters were implanted into fish captured in Fish Creek, N Fk Fish Cr, and S Fk Fish Cr. Thirteen 100 d transmitters were implanted in 200-350 gm fish, sixteen fish 350-525 gm received 35 d transmitters, and seven fish >525 gm were implanted with 283 d transmitters. Fourteen transmitters (9 100-d, 4 35-d, 1 283-d) were implanted in fish captured from 12,000 to 16,000 m of the North Fork of Fish Creek. Twenty-two transmitters (4 100-d, 12 35-d, 6 283-d) were implanted in fish from the lower reaches of the North and South Forks of Fish Creek, and 4,000-6,000 m of Fish Creek.

Locations for the Gros Ventre R drainage study area were recorded from 07/31/2001 - 10/31/2001 for the first summer-fall season, 01/24/02 - 06/13/02 for the winter-spring season, and 06/21/02 - 07/30/02 for the second summer-fall season. Tracking fish within the Fish Cr drainage was more difficult though without major disruptions. To locate fish in the vicinity of Fish Cr and the confluence of N Fk and S Fk Fish Cr, access was from the south through the Elk Track Ranch. Access to locate the fish between 12,000 and 14,000 m in N Fk Fish Cr was by Forest roads from the north.

RESULTS

Sixty-three Snake River cutthroat trout and four Yellowstone cutthroat trout were captured and surgically implanted with radio transmitters in mid to late-July 2001. Given that so few YSC were captured no distinction is made between SRC and YSC movements. We used telemetry relocations to determine the weekly, monthly, seasonal, and annual movements of each cutthroat trout. To summarize movements, fish were grouped into one of three categories based on transmitter life and fish size-class. The range of movements was summarized by total and seasonal movement of fish during the life of the transmitter. The seasonal movements were divided into three categories based on observed ranging behavior: first summer-fall, winter-spring, and second summer-fall season (Appendix B). Beginning and end of each season was established by apparent migration movements. A fall or spring *migration* exceeded the median and typically maximum movement observed for the previous season, and resulted in a fish relocating beyond the observed up- or downstream seasonal range. A season change was determined by the median date for all fish that displayed a migration outside its seasonal range.

We derived annual and seasonal ranges from movements exhibited by cutthroat trout in the Little Greys River and Fish Creek drainages. The *annual range* was determined by the greatest upstream and downstream distance (m) that a fish was located, where the life of the transmitter exceeded 300 days. Cutthroat trout in both drainages displayed distinct seasonal ranges during the study. We observed several fish to occupy a stream segment during the 2001 summer-fall season, establish a new range during the winter-spring 2002, then return to - or establish a new summer-fall range in 2002. S*easonal range* was determined by the greatest upstream and downstream distance (m) that a fish was located, during the *n*th summer-fall or winter-spring season. The respective season is identified as beginning after a fish had exhibited a migration; OR for fish where no migration was observed, a season begins on the median Julian date of fish that exhibited a migration within the same study area. Fall and spring migration-movements were observed by fish in both study areas. We also observed two distinct spring migrations (283-d transmitters only) by five cutthroat trout in the largest size-class (325-450 mm; 540-900 gm). In all cases, an initial migration was exhibited by fish to a presumed spawning location, and was then followed by a second presumed post-spawning migration to a summer range.

Little Greys River and Steer Creek

35-Day Transmitters

Five fish captured in the Little Greys River and four from Steer Creek were implanted with the 35-day transmitters. The nine fish consisted of eight SRC and one YSC. The average life of the 35-day transmitters was approximately 87 days. One fish (150.333) was never relocated after surgery, and a second mortality (150.283) was found with no clear cause of death. All other 35-day transmitters were believed to have expired, with the last fish in this group located on 11/09/01.

The total movements of the fish with 35-day transmitters are summarized in Table 1. Mean stream range occupied was 291 m. One fish (150.272) displayed a downstream movement pattern, and a second fish (150.342) moved upstream. Three fish performed up and down-stream movements and three fish did not move at all (Fig. 4).

The mean summer-fall range (SF-range) in 2001 was 231 m (Table 2). Seven fish had median movements of 0 m, and one fish had a median movement of 50 m. The average cumulative movement within the SF-range was approximately 330 m, and the average maximum single movement was about 212 m. The largest single movement observed was 900 m (150.272), and one cutthroat trout (150.342) exhibited a fall migration outside its SF-range in mid-October.

Three fish with 35-d transmitters were relocated early in the winter-spring season 2002 (Table 2); all transmitters had expired by mid-November. The start of the winter-spring (WS) season for the Little Greys R study area was 10/25/01, based on the median date of fall migrations by four cutthroat trout. Only one fish (150.262) displayed movement during the WS season. The fish was located three times during a period of three weeks. However, the fish was very active during those three weeks within its WS-range with a median movement of 200 m. Two fish (150.262, 150.342) remained in the same SF and WS ranges.

Table 1. Number of cutthroat trout, range of lengths and weights, transmitter life, and mean values for period of activity, number of locations, and total movement in the Little Greys River and Steer Creek.

Transmitter Life	Number of Fish	Length (mm)	Weight (gm)	Days Active (no.)	Locations (no.)	Stream Range (m)
35-day	8	317-375	340-510	87	11	291
100-day	12	265-322	210-320	146	12	1,176
283-day	10	371-440	540-900	338	18	1,680

Table 2. Mean ranging movements of cutthroat trout by transmitter life in the Little Greys River and Steer Creek for summer-fall 2001, winter-spring 2002, and summer 2002. Also, shown are average number of locations, period of activity, and distance measures.

Transmitter Life	Seasonal Range (m)	Locations (no.)	Days Active (no.)	Cumulative Distance (m)	Maximum Distance (m)	Migration Distance[1] (m)	Migration Distance[2] (m)
			Summer-Fall 2001				
35-day[3]	231	10	65	216	213	280	-
100-day[4]	1,158	11	67	1,154	963	517	-
283-day	675	8	50	755	670	-	-
			Winter-Spring 2002				
35-day[3]	100	2	14	167	100	-	-
100-day[4]	51	4	99	83	51	-	-
283-day	108	7	145	108	100	1617	2483
			Summer 2002				
283-day	67	4	45	133	67	-	-

[1] Mean only for those fish that exhibited a fall migration.
[2] Two spring migrations were observed only for cutthroat trout with 283-d transmitters.
[3] Transmitters expired by early-November.
[4] Transmitters expired by early-May.

100-Day Transmitters

Twelve fish, eleven captured in the Little Greys River and one in Steer Creek, were implanted with 100-day transmitters (Table 2); eleven were SRC and one YSC. The average life of the 100-day transmitters was 146 days. Four transmitters more than doubled the 100-day manufacturer's guaranteed life. Four fish were found dead. Predators were believed responsible for three deaths, and cause of the fourth mortality could not be confirmed.

The range of total movements observed for this group of fish spanned from 10 m to 5,000 m, with a mean of approximately 1,175 m (Table 1). Five fish displayed a downstream movement pattern (Fig. 5), and five fish moved up- and down-stream. One fish moved upstream, and another exhibited no movement. Movements displayed during the summer-fall 2001 for the 100-day transmitters were very similar to the slightly larger fish with the 35-day transmitters. All of the fish had a median movement of 0 m. The mean SF-range was 1,158 m, although half of the fish had a SF-range ≤200 m. Three fish displayed a fall migration from their SF-ranges. The median fall migration was 400 m. The longest single movement (150.053) observed was 5,000 m. Another fish (150.161) exhibited the largest cumulative movement of 5,100 m. Both of those fish made a single movement >4,000 m during early August that were

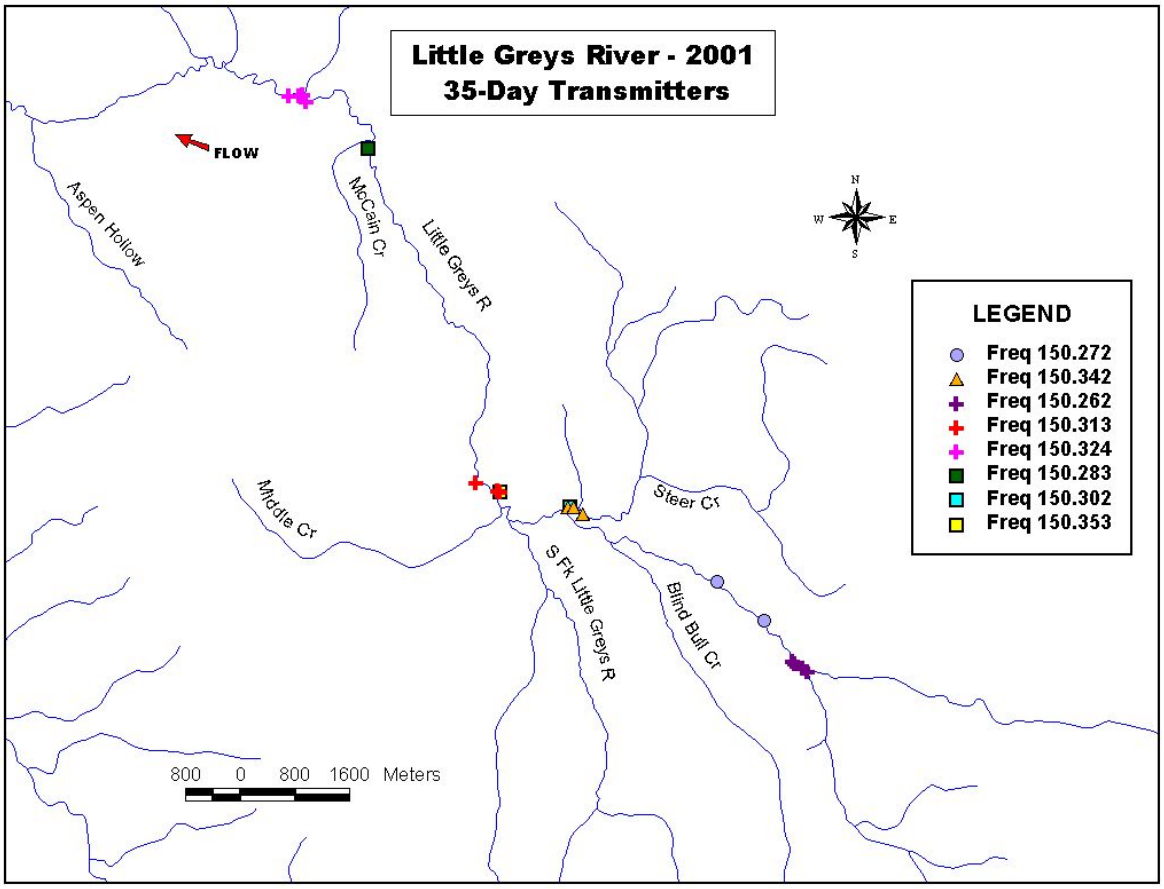


Figure 4. Cutthroat trout locations in the Little Greys River drainage during summer-fall 2001. Circles represent fish that exhibited downstream movement, triangles represent upstream movement, crosses represent both up- and downstream movement, and the squares represent no movement. (Map displays all relocations, including mortality locations.)

suspected of being post-surgery acclimation movements. The average cumulative movement for the summer-fall was 1,325 m, and an average maximum movement of 963 m was observed. However, most fish stayed within their SF-range and did not move very frequently.

Eight fish were located during the winter-spring 2002 season. No movements were observed for five of the fish, and the remaining three exhibited little movement. One fish (150.003) displayed a WS-range greater than 100 m, and one fish (150.191) had a median movement >0 m. All the transmitters expired prior to the spring migrations exhibited by the largest size-class of cutthroat trout.

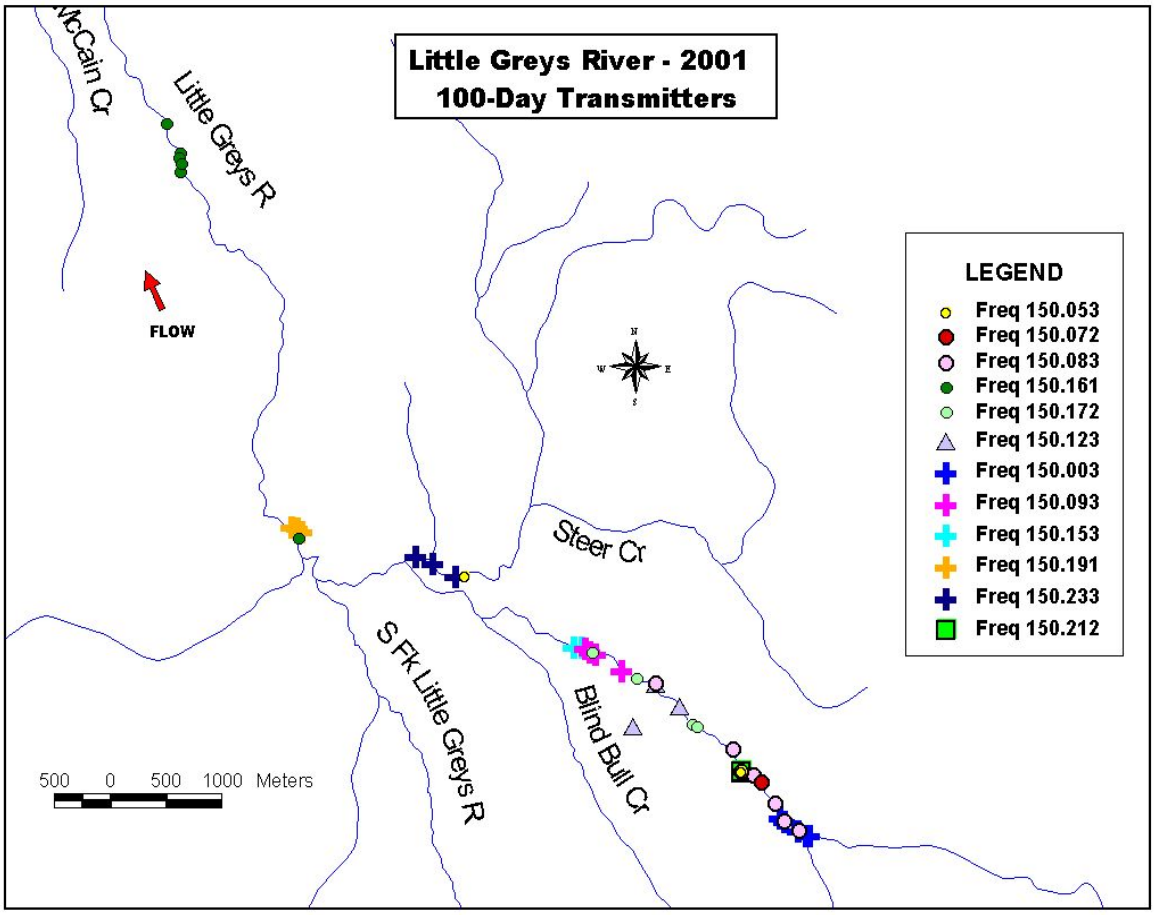


Figure 5. Summer-fall 2001 and winter-spring 2002 cutthroat trout locations in the Little Greys River drainage. Circles represent downstream movement, triangles represent upstream movement, crosses represent both up- and downstream movement, and squares represent no movement.

One fish (150.233) implanted with a 100-day transmitter in 2001 was recaptured on 08/04/02. The fish was captured in lower Steer Cr in the same area it displayed a home range in the summer-fall of 2001. The fish was in very good condition. The transmitter was surgically removed and the fish released in the same habitat unit it was captured.

283-Day Transmitters

Ten fish were implanted with 283-d transmitters (Table 2), nine from the Little Greys R and one in Steer Cr. Nine were SRC, and one YSC. The average life of the 283-d transmitters was 338 days. Nine mortalities were found during relocations. There was strong evidence that predators had killed two fish. Anglers were believed responsible for two mortalities, though only one could be confirmed. Causes of the remaining five mortalities were not confirmed. One fish

(150.553) was found dead during the first location, and may have been a post-surgery mortality, and a second fish (150.525) was found dead two weeks after surgery. Six transmitters had surpassed the 283-d guaranteed life. One transmitter was active through 08/04/02 (150.565; 383 days), the longest duration of all fish tagged in 2001. This was also the only fish from this group that was not a known mortality.

The mean annual range observed for the larger cutthroat trout (540-900 gm) with the 283-d transmitters was 1,680 m, and 40% of these fish displayed no movement at all. One fish exhibited downstream movement, and two fish moved upstream (Fig. 6). Another three fish moved in an up- and downstream pattern within their annual range, and four fish exhibited no movements. Two transmitters (150.544 and 150.695) that were tracked over the winter 2002 moved downstream during spring, however, we believe these were natural mortalities and the transmitters carried by the spring run-off. The transmitters emitted mortality signals all winter and were recovered after run-off.

Summer-fall ranges of the fish with 283-d transmitters were very similar to those of smaller size-classes with 35 and 100-day transmitters. All the fish had a median movement of 0 m, and no fall migrations were observed. The mean SF-range was 50 m. One fish (150.573) exhibited the largest single and cumulative SF movements, and SF-range. However, there was one large movement made by that fish in early-to-mid August leading us to believe that the fish was still acclimating after surgery. Three of the fish performed more than one movement within their SF-range.

We obtained relocations for six fish during winter-spring 2002, two of which were presumed mortalities early in the season (see above). All of the fish had median WS-ranges of 0 m, although we did observed movements by two fish within their WS-range. Three fish (150.565, 150.595, and 150.695) survived the winter and exhibited spring migrations of 1,050-4,800 m that coincided with the spawning period. All three fish made one migration outside of their WS-range by early-May, followed by a second migration in late-May or early-June. One fish migrated downstream of its WS-range, than returned for the summer. Another fish migrated upstream, than returned downstream to its original SF and WS-range. A third fish made the largest spring migration 2,400 m downstream of its WS-range, entered and remained in McCain Cr during the spawning period, and subsequently made a second migration of 4,800 m downstream and was killed by an osprey.

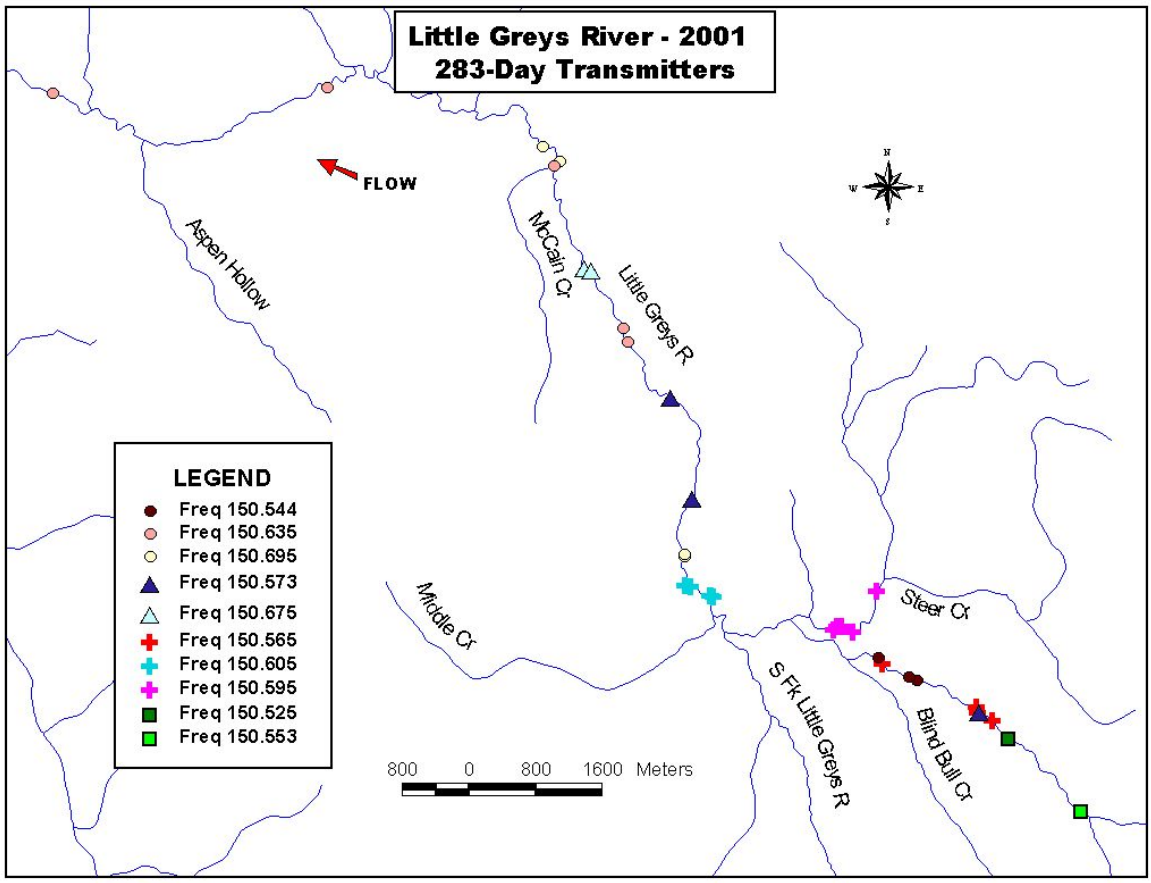


Figure 6. Locations of cutthroat trout in the Little Greys River drainage, from August 2001 to August 2002. Circles represent downstream movement, triangles represent upstream movement, crosses represent both up- and downstream movement, and squares represent no movement.

Transmitters remained active for three fish into the summer-fall season of 2002. One fish was relocated once (150.595) in early-May, and a second fish (150.635) in late-May and early June. The transmitter of the third fish (150.565) was active through early-August. After exhibiting spring migrations, that cutthroat trout remained within a SF-range of 200 m, and made two movements (200 m each) although it remained relatively sedentary until the tag expired.

Fish Creek, North Fork Fish Creek, and South Fork Fish Creek

35-Day Transmitters

Sixteen fish were implanted with 35-d transmitters (Tables 3 and 4) include fifteen SRC and one YSC. Four fish were captured in an upstream reach (12,000-16,000 m) of N Fk Fish Cr (Fig. 7). Another twelve fish were captured in Fish Cr, the N Fk Fish Cr and S Fk Fish Cr,

Table 3. Number of cutthroat trout, range of lengths and weights, transmitter life, and mean values for period of activity, number of locations, and total movement in Fish Creek, North Fork Fish Creek, and South Fork Fish Creek.

Transmitter Life	Number of Fish	Length (mm)	Weight (gm)	Days Active (no.)	Locations (no.)	Stream Range (m)
35-day	16	324-392	340-510	54	8	367
100-day	13	282-341	220-340	177	12	696
283-day	7	319-439	540-750	349	9	586

Table 4. Mean ranging movements of cutthroat trout by transmitter life in the Fish Creek, North Fork Fish Creek, and South Fork Fish Creek for summer-fall 2001, winter-spring 2002, and summer 2002. Also, shown are average number of locations, period of activity, and distance measures.

Transmitter	Seasonal Range (m)	Locations (no.)	Days Active (no.)	Cumulative Distance (m)	Maximum Distance (m)	Migration Distance[1] (m)	Migration Distance[2] (m)
			Summer-Fall 2001				
35-day[3]	184	7	41	291	175	1,500	-
100-day	325	10	60	606	265	858	-
283-day	125	5	65	443	129	-	-
			Winter-Spring 2002				
35-day[3]	46	2	5	46	46	-	-
100-day[4]	141	3	42	185	125	-	-
283-day	233	6	241	567	267	1,000	1,350
			Summer 2002				
283-day	325	7	57	325	325	-	-

[1] Mean only for those fish that exhibited a fall migration.
[2] Two spring migrations were observed only for cutthroat trout >540 gm with 283-d transmitters.
[3] Transmitters expired by late-October.
[4] Transmitters expired by early-May.

and released at the confluence or a short distance downstream (Fig. 8). The average life of the 35-day transmitters within the Fish Creek study area was 54 days. The last fish (150.473) within this group was located on 10/31/01. All but four transmitters were believed to have expired. A single mortality (150.483) by angling was confirmed, and evidence suggested three mortalities by anglers or predators.

The four fish in the upper reach of N Fk Fish Cr exhibited little movement, and six of the fish near the confluence displayed no movement. Three of the four fish in the upper reach had a total stream range of 150 m, one never moved from the habitat unit where released during the duration of the tag, and all four remained within a single pool-complex (Fig. 7). The mean stream range occupied by these fish was approximately 370 m (Table 3), however, four of the sixteen were located two or less times. One fish displayed a downstream movement pattern, four

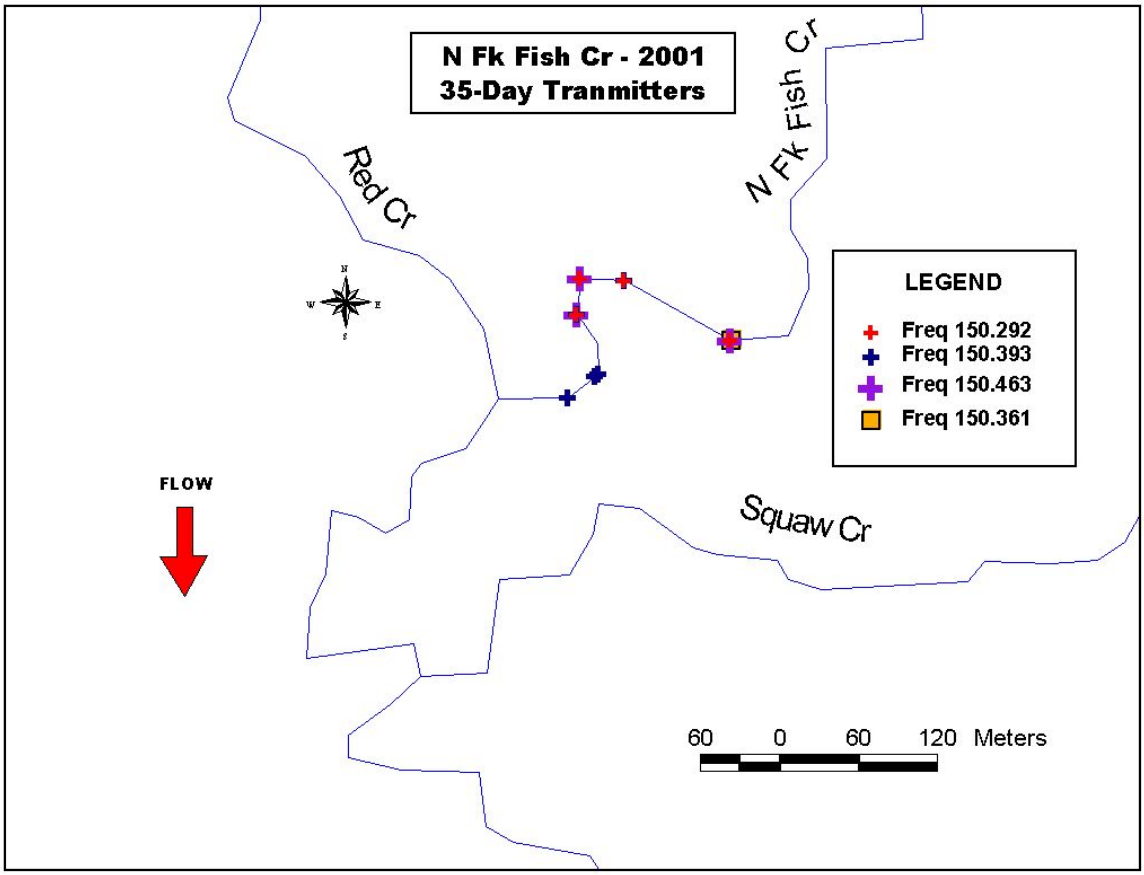


Figure 7. Cutthroat trout locations in the upper reach (12,000-16,000 m) of the North Fork Fish Cr during summer-fall 2001. Circles represent downstream movement, triangles represent upstream movement, crosses represent both up- and downstream movement, and squares represent no movement.

fish made upstream movements, and four fish moved up- and down-stream. Two of the fish in Fig. 8 (150.443 and 150.453) appear to move downstream only because the transmitters were found downstream of their last live location.

Both the upstream and confluence groups exhibited limited movement during summer-fall and winter-spring seasons. Three of the twelve fish were observed to move more than once within their SF-range. Two of the sixteen fish had median movements of 25 m, and mean SF-range was 184 m. This group displayed an average cumulative movement of 291 m, and an average maximum of 175 m. All transmitters expired in the upper reach of the N Fk Fish Cr before the end of the summer-fall season. Two fish in the confluence area exhibited fall migrations of ≥1000 m outside their SF-range in early-October. Six of the twelve fish in the

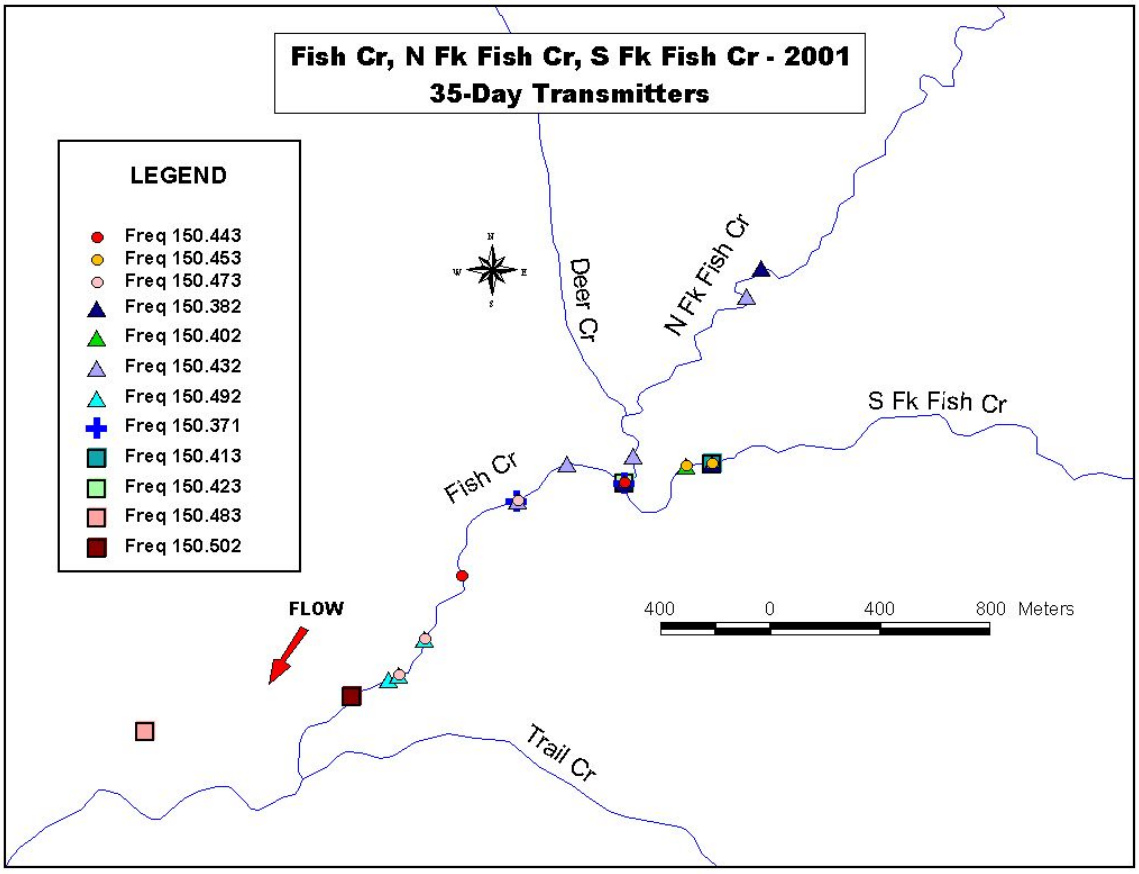


Figure 8. Cutthroat trout locations near the Fish Cr, North Fork Fish Cr, and South Fork Fish Cr confluence, during summer-fall 2001. Circles represent downstream movement, triangles represent upstream movement, crosses represent both up- and downstream movement, and squares represent no movement.

confluence area were located ≤3 times early in the winter-spring 2002 season. Only one fish displayed median, mean, cumulative and maximum movements >0 m before all transmitters expired at the end of October.

100-Day Transmitters

Thirteen SRC captured near the confluence of Fish Cr, N Fk Fish Cr, and the S Fk Fish Cr were implanted with 100-d transmitters (Table 3). All of the transmitters expired before any mortality was observed, and the last fish was located on 03/26/02. The average life of these transmitters was 177 days.

Cutthroat trout in the 100-d transmitter group exhibited more diverse movement than was observed for the 35-d group (Fig.'s 9 and 10). The mean total stream range was 696 m. Three of the fish exhibited an upstream movement pattern, and four fish moved downstream. Five fish

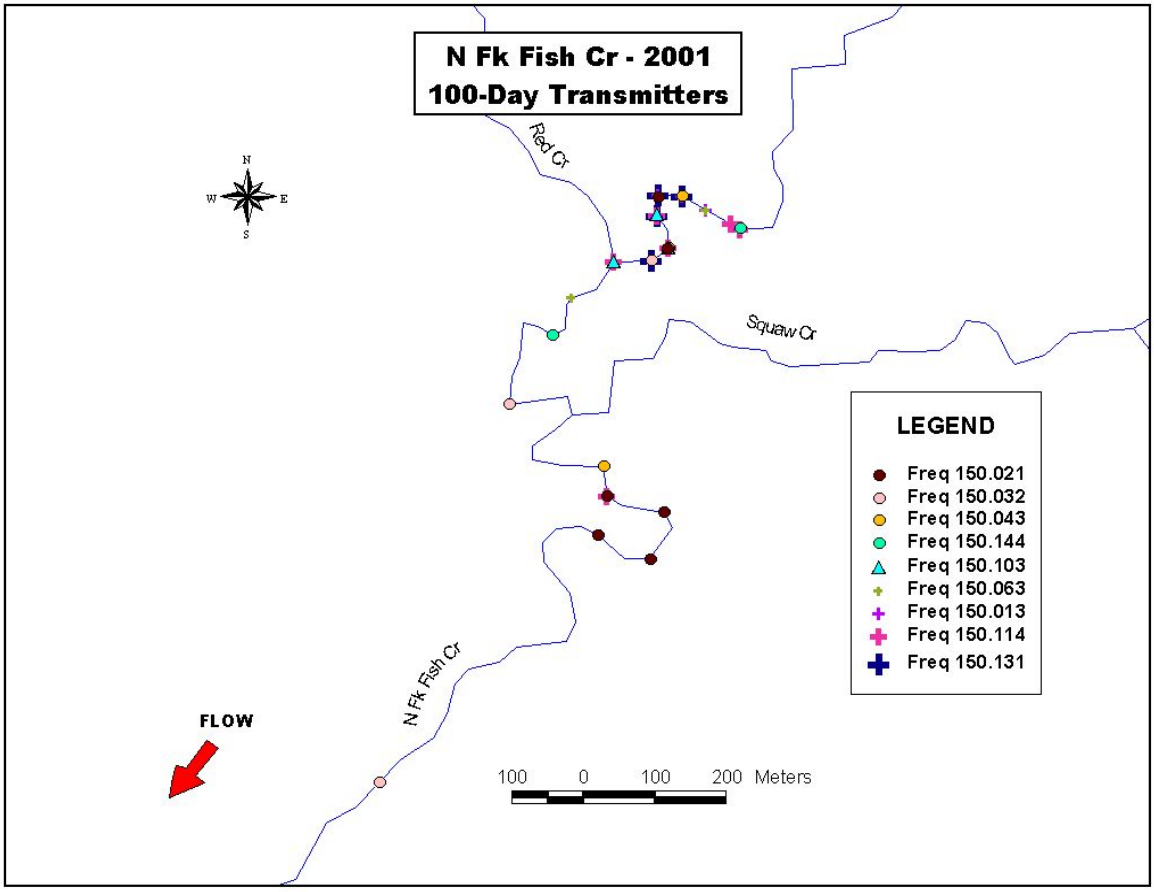


Figure 9. Summer-fall 2001 and winter-spring 2002 cutthroat trout locations in the upper North Fork Fish Cr drainage. Circles represent downstream movement, triangles represent upstream movement, crosses represent both up- and downstream movement, and squares represent no movement.

moved both up- and downstream in their total stream range, and we observed one (150.243) fish that displayed no movement.

This was an active group of fish within their SF-range, making short but frequent movements (Table 4). Median movements of four fish were 25-50 m and nine had a median of 0 m. Mean SF-range for this group was 325 m. The average cumulative and maximum movements were 606 and 265 m, respectively. Six fish exhibited fall migrations in early October, three of which were ≥1000 m. The entire group was tracked into the winter-spring season of 2001-2002, though all transmitters had expired by April. These fish were located an average of 3 times, though we had 4-7 relocations for five fish during the winter-spring season. Two fish had median WS-ranges >0 m, and the mean WS-range was 141 m for the group. The average cumulative and maximum movements were 185 and 125 m, respectively.

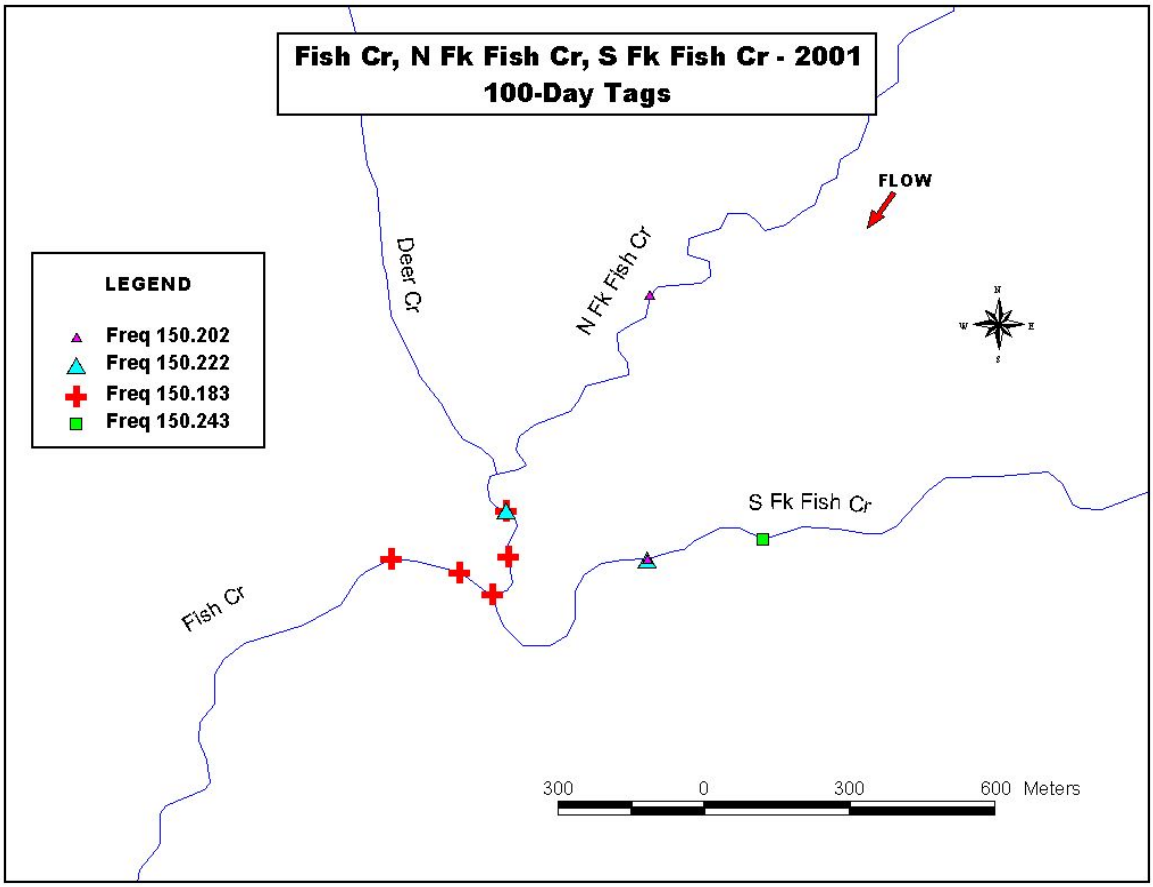


Figure 10. Summer-fall 2001 and winter-spring 2002 cutthroat trout locations near the Fish Cr, North Fork Fish Cr, and South Fork Fish Cr confluence. Circles represent downstream movement, triangles represent upstream movement, crosses represent both up- and downstream movement, and squares represent no movement.

283-Day Transmitters

Seven SRC captured near the confluence of Fish Cr, N Fk Fish Cr, and the S Fk Fish Cr were implanted with 283-d transmitters. Four of these were found dead during the first week of locations. Two of the mortalities had no clear cause given that only the transmitters were found. A third mortality was determined to have been caused by predation. The fourth mortality was believed to be a result of surgery. The three remaining transmitters had an average life of 349 days (Table 3). Two transmitters expired, and the third fish was located through 08/12/02 when it was found dead of apparent natural causes.

One fish was captured and its movements tracked in the upper reach of the N Fk Fish Cr (Tables 3 and 4). This fish (150.533) exhibited up- and downstream movements in all seasons

within an annual range of 2800 m (Fig. 11). During 2001 this fish moved frequently within a 900 m SF-range, though no fall migration was observed. Median distance moved was 50 m, and

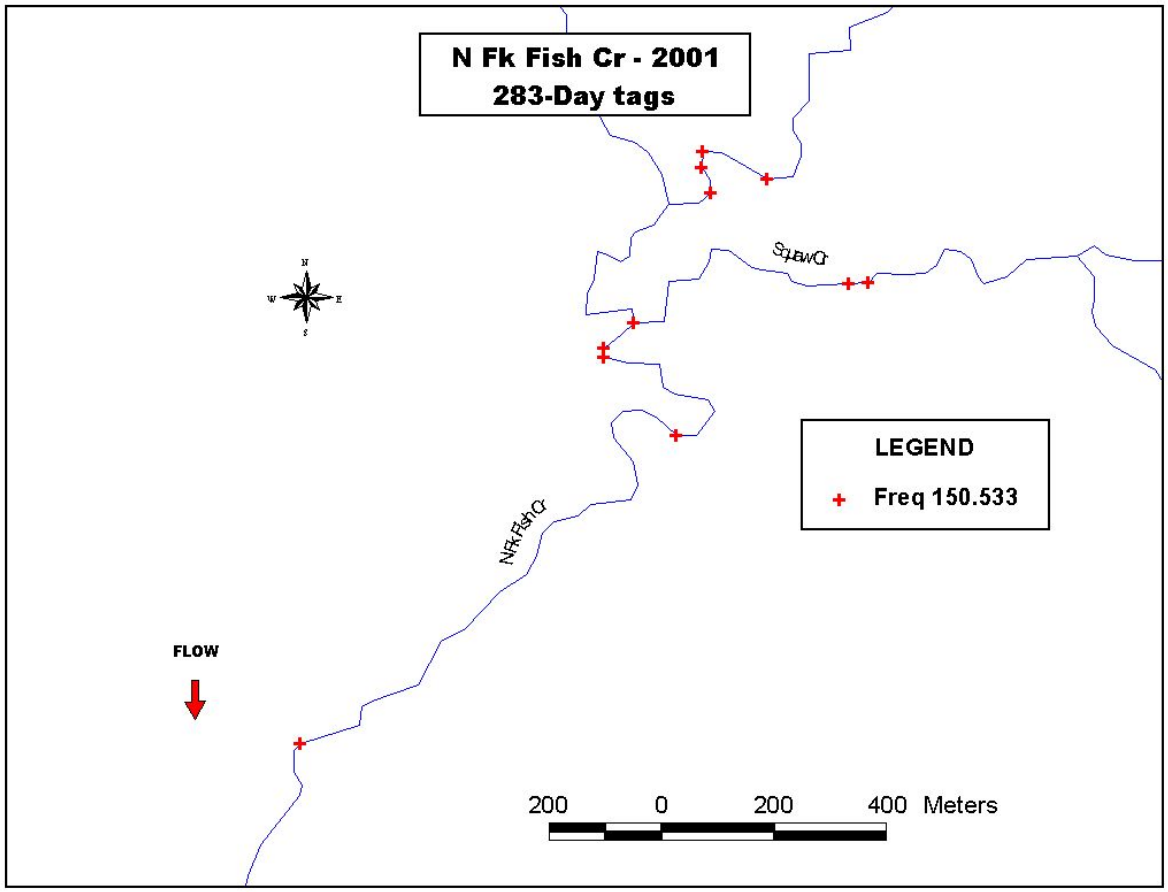


Figure 11. Summer-fall 2001 to summer-fall 2002 cutthroat trout locations in the upper North Fork Fish Cr drainage. Crosses represent both up- and downstream movement.

the cumulative and maximum movements were 3,100 and 900 m, respectively. The fish remained active within a 500 m WS-range. Winter-spring median movement was 50 m, and the cumulative and maximum movements were 600 and 500 m, respectively. The fish exhibited an initial downstream migration of 1,000 m during spring run-off in early-May, and a second 1,400 m upstream migration in early-June. The fish subsequently entered Squaw Cr (Fig. 11), moved once (450 m) during the summer of 2002, and remained in that location until was found dead downstream on 08/12/02.

Only one of the two fish that survived beyond the second week post-surgery near the Fish Cr, N Fk Fish Cr and S Fk Fish Cr confluence could be located routinely into the summer 2002.

Though the transmitter signal (150.595) was inconsistent, one fish was always found at the confluence of N Fk and S Fk Fish Cr, but there were extended periods over 297 days that it could

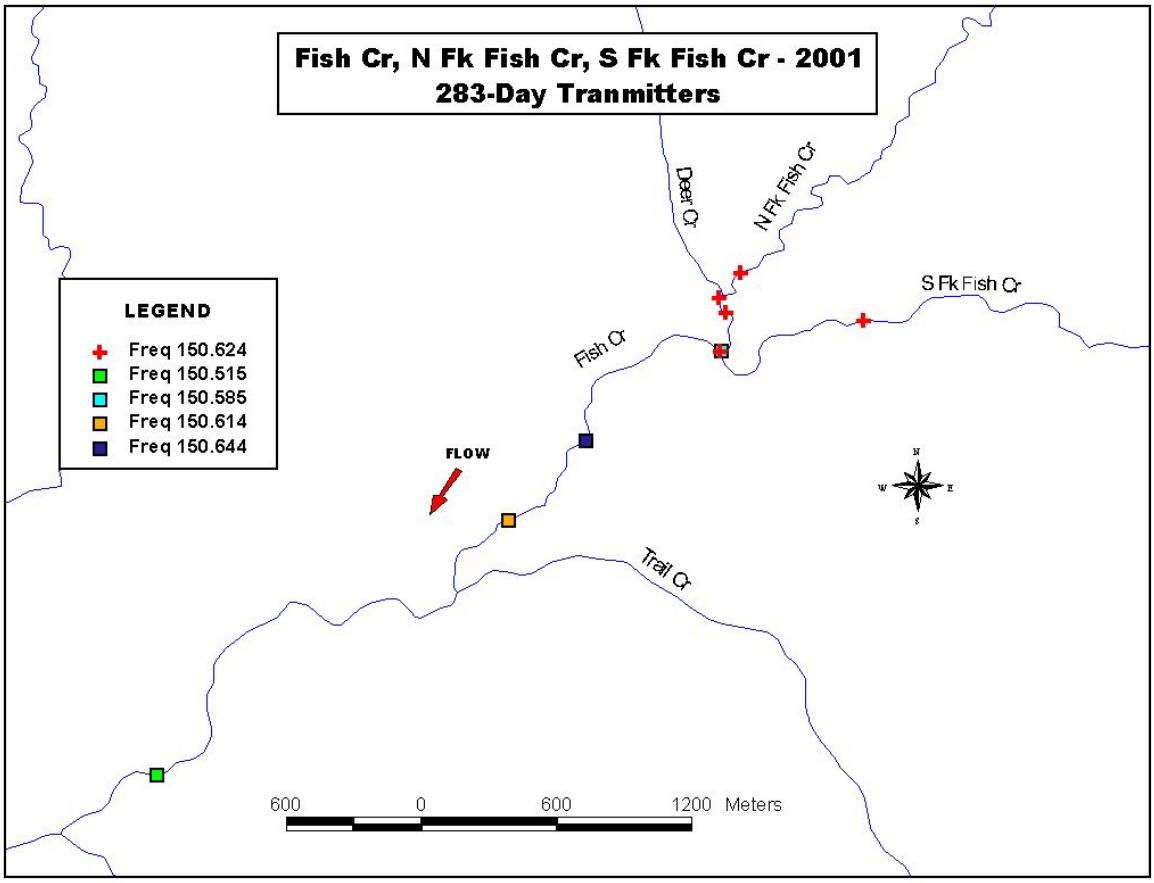


Figure 12. Distribution of fish implanted with large size, 283-day transmitters within the lower Fish Cr drainage. Crosses represent back and forth movement and squares represent no movement. (150.655 not mapped due to no written, geo-referenced, or map location)

not be located. Neither fish displayed movement during the 2001 summer-fall season. The second fish (150.624) occupied a 1,300 m annual range, and exhibited periodic up- and downstream movements only during the winter-spring and 2002 summer seasons (Fig. 12). This fish occupied the same 200 m for both the winter-spring and summer 2002 ranges. The fish also exhibited two migrations in spring 2002 that coincided with the spawning period. In early June, the fish moved 1,000 m from the N Fk Fish Cr into S Fk Fish Cr, and returned 1,300 m back into its original home range one week later. The fish made one movement of 200 m during the summer 2002 season prior to the transmitter expiring.

DISCUSSION

Overall, the telemetry project proved to be highly successful. Mortalities during and following surgery were minimal, and data collection improved over time. Radio telemetry was proved to be a very effective method to determine cutthroat trout annual and seasonal ranging behavior, and we gained previously unconfirmed insights into seasonal migrations in headwater tributaries of the Snake River in Wyoming. Another important observation was that mean movements (or average value) tend to be heavily skewed by a few fish exhibiting large or small ranging movements, and therefore, median movements (the "middle" value in a set of movements arranged from shortest to longest) appear to be the most informative.

Total stream range for 46 of 67 fish monitored was 0-500 m (Fig. 13), indicating the majority of cutthroat trout we tracked could be considered residents of the streams they occupy. Total stream range occupied was found to be similar in both the Little Greys R and Fish Cr study areas (Fig. 14). However, on average, the fish in the Greys River drainage displayed greater movement (APPENDIX B Table 5). The fish with the 100-d transmitters had an average total stream range of 948 m, the fish with the 35-day transmitters had an average total stream range of 344 m, and the fish with 283-day transmitters had an average total stream range of 1,229 m. Though the larger fish occupied a greater total stream range, no spring migrations could be recorded for the fish implanted with 35-d and 100-d transmitters. Therefore, no conclusion can be determined of an annual stream range for those fish.

An anomalous movement pattern we observed were migrations immediately after surgery by three fish (150.053, 150.161, 150.573) in the Little Greys R study area. All fish were allowed a period of approximately 1 week to acclimate following surgery. All three of these fish made a very large movement within 1-2 weeks post- surgery, moving 4600 m to 6000 m. These are considered anomalies because no other fish displayed similar post-surgery movements. The first fish moved downstream in the Little Greys R and then upstream in Steer Cr before completing its 5000 m journey. The second made a downstream movement of 4600 m, and the last an upstream movement of 6000 m. These were puzzling observations given that we captured fish approximately one month after spawning in 2001, and well after the observed spring migrations we documented in 2002. In addition, due to low densities of fish it was necessary to capture them over several kilometers of stream, and it is unknown whether these three fish were attempting to

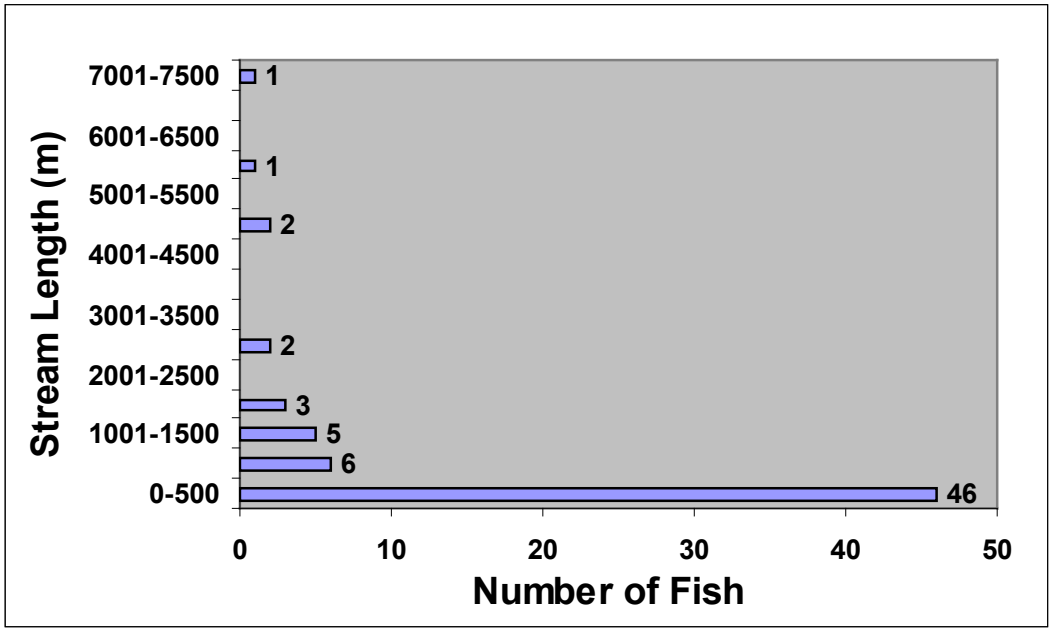


Figure 13. Frequency of total stream range observed for sixty-seven cutthroat trout based on telemetry locations from August 2001 to August 2002.

relocate to the stream reaches where captured, versus avoiding the release location after surgery. Therefore, these movements were retained in our calculations for SF-range, though not considered migratory behavior.

The SF-range is comparable to the total and annual stream ranges for most of the fish observed (Fig. 15). The fish within the Little Greys R study area had an average SF-range of <400 m, and the fish in the Fish Cr study area had an average SF-range of <1100 m. The most active fish within the SF-ranges where located within the Gros Ventre R drainage. Those fish exhibited more median movements >0 m. Average cumulative movements where somewhat greater in the Little Greys R drainage, due mainly to the few large movements immediately after surgery. The most significant summer-fall movements were the fall migration observed in September-October 2001.

Fall migrations appeared to be associated with either a decline in water flow or temperature, or both, and may have been related to fish to seeking over-wintering habitat. None of the larger size-class fish with 283-d transmitters performed a fall migration. Twelve fish displayed a fall migration in 2001. Four fish in the Little Greys R exhibited migrations between

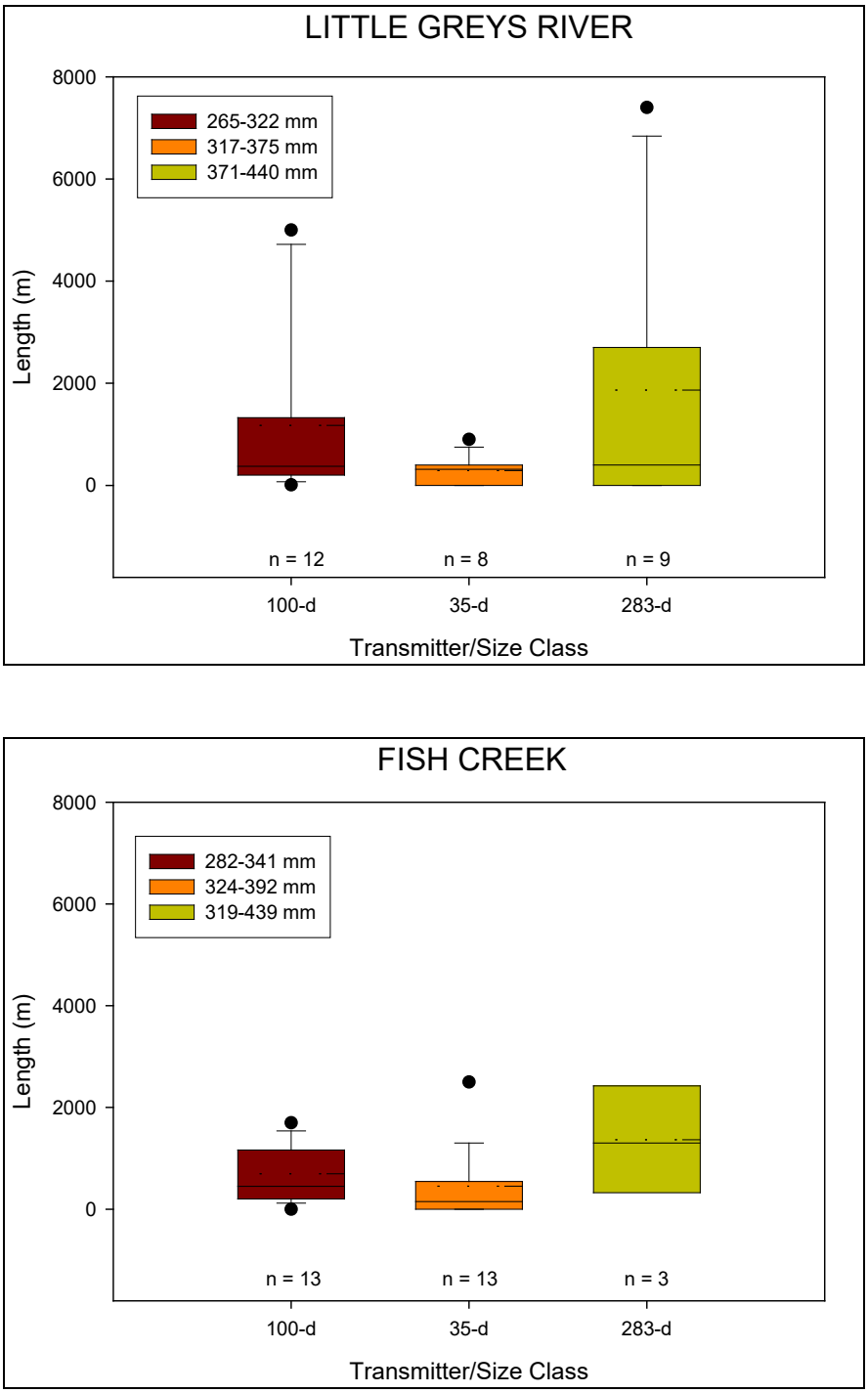
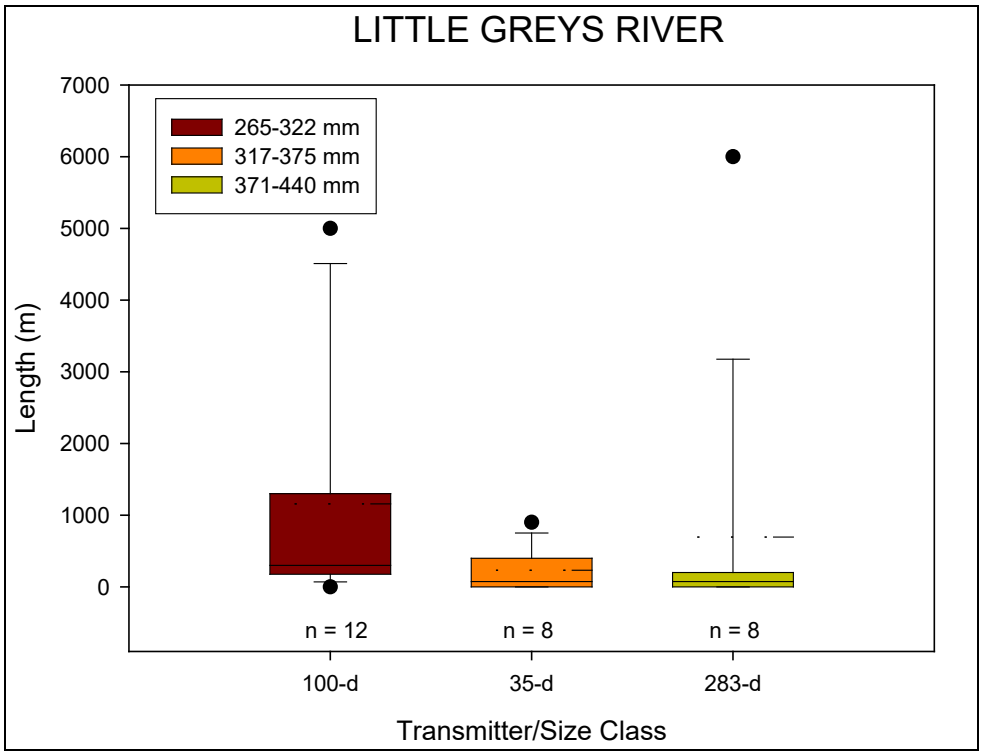


Figure 14 Total stream range occupied by cutthroat trout in the Little Greys River and Fish Creek study areas for summer-fall 2001 to summer-fall 2002. Movements are displayed as box-and-whisker plots, where lower and upper bounds of boxes are the 25th and 75th percentiles of movements observed, medians are the solid lines, and means are the dashed lines; the black dots are outliers, representing migrations or fish that did not move. Total range for fish implanted with 35-d and 100-d transmitters are from July 2001 to late October 2001 and late March 2002, respectively, and include fall migrations (200-2000 m). The total range of fish implanted with 283-d transmitters is from July 2001 through May 2002, include spring migrations (1000-4800 m), and represent annual ranging behavior.



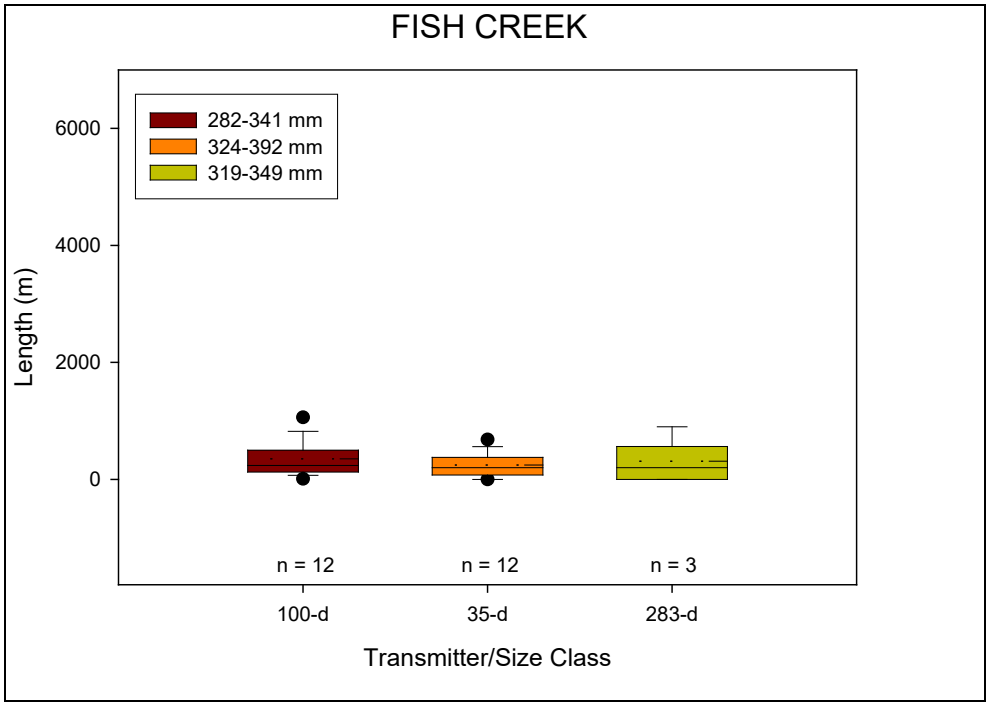


Figure 15 Summer-fall range occupied by cutthroat trout in the Little Greys River and Fish Creek study areas during 2001. When viewed by season, smaller size-class fish exhibited larger movements in the Greys River drainage. Summer-fall movements in the Gros Ventre River drainage were similar for all size-classes of fish. Most fish exhibited summer-fall ranges of 200-500 m, and large movements by a few fish (4 of 20 in the LGR, and 8 of 24 in the GVR) were mainly attributable to a fall migration.

10/12/01 and 11/09/01, three in the Fish Cr drainage between 09/09/01-09/18/02, and five additional fish in the Fish Cr area between 10/02/01 and 10/15/01. The upper reach of N Fk Fish Cr had 6 fish exhibit migrations, the highest number observed in one area. The fish in the Gros Ventre drainage also had the longest fall migration distances.

Twenty-six fish had a WS-range of 0 m. Seven fish in the Little Greys R study area and six fish in the Fish Cr study area had winter-spring ranges >0 m. Twenty-eight fish could not be located during the winter-spring season of 2001-2002 because of mortalities and transmitter expiration. Six of the thirteen fish that had a WS-range >0 m had a median WS movement >0 m. Also, twelve of those same thirteen fish had a WS-range of <500 m. Overall, most of the fish did not leave a single habitat unit during the winter-spring season (Fig. 16).

We were unable to continue locations for twenty-one of the twenty-six fish through the end of the winter-spring season. The remaining five transmitters were successfully tracked throughout the entire winter-spring 2002, spring run-off and spawning period. Those five fish were all implanted with the 283-d transmitters. Three fish in the Little Greys R and two fish in the Fish Cr drainage performed two distinct movements. Thus, the spring season of 2002 was the most active period we had observed.

The three Little Greys R fish performed their first spring migration during the first week of May 2002. The first migration of each fish was greater than 1,000 m, and a second migration ≥1200 m was documented on May 30, 2002. Two fish (150.565 and 150.595) made their first migration to an area of the river where spawning redds were observed, and the second migration back to its WS-range. The third fish (150.635) first migrated downstream in the Little Greys R, entered McCain Creek, and migrated a week later back into and downstream in the Little Greys R. Two of the fish (150.635 and 150.595) were found dead a week after their second migration.

The spring migrations observed by the fish (150.533 and 150.624) in the Fish Cr drainage were quite similar. One (150.533) made its first spring migration 1,000 m downstream in the N Fk Fish Cr prior to May 15, 2002, and its second migration 1,400 m back upstream between June 6, 2002 and June 21, 2002. The fish made its first migration into a known spawning area and its second migration back into its original SF and WS-range. The initial spring migration by the second fish (150.624) was 1,000 m from the N Fk Fish Cr to S Fk Fish Cr between June 6, 2002

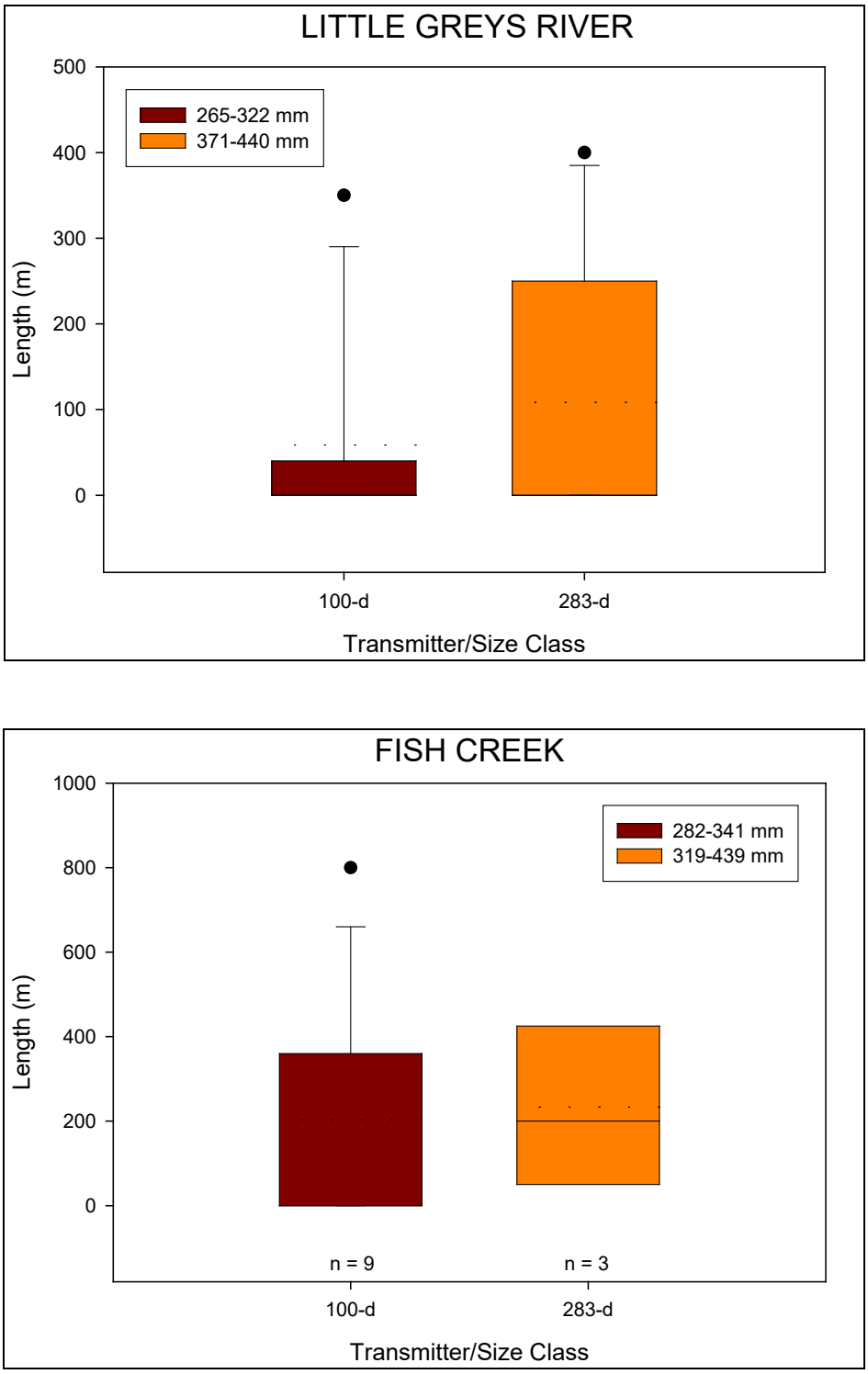


Figure 16 Winter-spring ranges showed a somewhat different pattern, with larger size-class fish exhibiting a greater movement overall, and slightly higher minimum distances. Most fish in both size-classes had winter-spring ranges of 0-500 m, and most of the movement observed by large size-class fish (4 of 6 in LGR, and 2 of 3 in the GVR) was attributable to spring migrations (assumed to be spawning movements). Note that vertical scales differ.

and June 13, 2002. The second migration observed was a 1,300 m movement back into the N Fk Fish Cr between June 13, 2002 and June 21, 2002. This fish also returned to its previous SF and WS-range.

Four of the five fish that appeared to make spring spawning migrations made two large movements from early to later May 2002. One fish performed its spawning migrations during June. The spring run-off begins about two weeks earlier in the Little Greys R drainage because of lower elevation and higher air temperatures. This could explain why the fish in the Little Greys R began spring migrations before the fish in the Fish Cr drainage.

The same five fish were observed during the 2002 summer-fall season. However, two of the fish would die before June. Only one fish (150.565) in the Little Greys R drainage was located into the summer months. The fish had a SF-range of 200 m, moved only one time during the entire summer, and was last located on August 4, 2002. One fish (150.624) in the lower 2,000 m of the N Fk Fish Cr also established a second SF-range of 200 m in 2002. This fish also made one movement during the summer-fall season prior to the transmitters' expiration. The third fish (150.533) was in the upper reach of the N Fk Fish Cr, established a 2002 SF-range of 450 m in Squaw Cr, and made one movement during the season as well.

Overall, cutthroat trout in the Greys R and Gros Ventre R drainages exhibited similar weekly, seasonal, and annual patterns of movement. Ranging movements were less than <500 m for the majority of fish, with many remaining in the same habitat unit throughout the duration of the transmitters' life. However, all of those 46 fish were either implanted with radio transmitters that expired during fall 2001 or winter 2002 or died, and could not be relocated for an entire year. Thus, it is uncertain whether all of the 46 represent local resident fish. We observed that few fish exhibited migrations between summer-fall and winter-spring seasons, and all of the fish with active transmitters into the 2002 spring season performed two distinct migrations. Ranging behavior observed in the two river drainages suggests an admixture of life histories, including local stream residents and fluvial migrants. The latter utilizing various habitats within connected streams, over a length of 1000 m to 5000 m, for summer feeding with favorable growth conditions, over-winter refugia from harsh environmental conditions, and spring spawning and egg incubation. In some cases these fish were able to locate habitats favorable for both summer and winter seasons within the same stream reach.

Mortality Summary

Three mortalities occurred with fish captured in the Little Greys R study area that were attributed to stress from surgery. In each case the fish was revived and returned to holding tanks in the stream, but expired within approximately 1 hour. There were no surgery related mortalities with fish captured in the Fish Cr study area. However, several fish (150.483, 150.644, 150.515, and 150.614) did experience difficult and lengthy (4-6 minute) surgical procedures. Those fish were unconfirmed mortalities in the weeks following their release. However, evidence suggested each may have been killed by anglers or predators. Six fish were found within the first week of locations and another four within the first two to three weeks of locations. Although some of these fish were found to have been eaten by predators, stress from surgery may have caused the mortalities and predators scavenged the carcass. Angler mortality is suspected in all cases due to the fish being released in a large pool formed by the confluence of the N Fk Fish Cr and S Fk Fish Cr, an area popular among local anglers.

Predation, angling, natural causes, and stress from surgery were all factors in the mortalities observed. Twenty-three (34%) of sixty-seven fish were found dead between August 2001 and August 2002 (Table 6). Thirteen of the mortalities were observed in the Little Greys R drainage and ten in the Fish Cr drainage. Predation was confirmed to have caused eight mortalities. Five of these mortalities occurred within the Little Greys R drainage. Predation was the highest single cause of mortality. Both study areas are occupied by bald eagles, osprey, great blue herons, mink, and otters. Anglers were confirmed to be the cause of two mortalities on the Little Greys R. However, there were four additional unconfirmed mortalities that likely resulted from either predation or angling. In particular, Little Greys R fish are assumed to be more susceptible to angling because of Forest road access and high recreation use throughout the summer and fall. Five fish were believed to have died by natural causes other than predation in the two study areas (150.283, 150.533, 150.544, 150.605, and 150.695), given that the carcasses were found in the stream with no evidence of trauma. In each case the fish had survived until spring 2002.

Finally, 14 of 17 of the fish with the 283-d transmitters died within one year. Large tag size, age of fish, or large body size may have influenced these mortalities. The 283-d transmitters are twice as large as the 35-d and 100-d transmitters, these transmitters may cause internal damage although field necropsies revealed no indication of internal trauma. It is

assumed, and evidence suggests that these five fish were repeat spawners, that may have succumbed to the severe energy demands following their second successive year of reproductive effort.

TELEMETRY RECOMMENDATIONS

Several simple procedures increased efficiency of locating fish using radio telemetry. Our crews made several suggestions for both tracking and the surgical procedures. Many of the following recommendations were implemented throughout 2001 and 2002. However, there are still areas that require improvement (i.e., GPS data collection, and data recording).

1) Keep vehicle and gear organized. Simple as it sounds, it is often overlooked. Update data sheets, change maps, and remove mortality pages immediately upon returning to office. This is particularly necessary when another crew member will conduct the next locations.

2) On the data sheet, clearly state the reach distance a fish was located in. Write a physical description of the location, and use landmarks that are consistent. This is the single most important thing that can be done for the next crew member conducting locations.

3) When writing the physical description of the location, do not to write "50 m upstream from 150.292." This is confusing, and forces the recorder to sift through data sheets for 150.292.

4) When writing the physical location, use only established habitat type acronyms to describe the location (e.g., SLM, SPW, RUN).

5) Use temperature loggers in each basin throughout the season, for consistent temperature records.

6) Do not leave the office alone without a hand-held Forest-net radio. Take extra batteries and a repeater and channel guide.

7) The receiver antenna works only when held with tines vertical. If it seems like the receiver is picking up the fish in all directions, even as gain is lowered, point antenna at the ground to see if transmitter is on the bank.

8) Store the receivers in a heated building. The vehicle in winter is too cold. Charge the receivers each night after tracking, so they are always ready to go.

9) After completing locations remove telemetry gear from the truck, including antennas, in case there is some type of emergency (e.g., fire emergency) where the truck is used and the equipment might be gone until the truck is returned.

10) After locating a fish, and the gain and power readings are giving you a positive location, disturb the fish. If you see the fish or pick up movement with receiver, then you can be certain fish is alive. Note this effort and status on data sheet.

11) While tracking, carry magnets with you to turn off any transmitter you recover; otherwise they will interfere with continued tracking. Also bring a larger magnet to surgery sites for resetting programmed transmitters already implanted in a fish.

12) This is not a foot-race, enjoy being outside tracking instead of in the office for the day. Take the time to be thorough and accurate. Take pride in your work.

13) Clearly date each map, and use each map for two tracking sessions. Writing one week's locations on the north side of stream, and the next week on the south side. Make certain that maps are marked consistently.

14) To better understand the fish movements, locations a fish has been located in could be snorkeled or sampled by rod and reel.

15) Develop a more mobile surgery station. This would reduce stress on fish caused by being transported in buckets to the surgery site. This would allow surgeries to be performed and fish released nearby the original capture location, and minimize stress on fish.

16) Attempt to implant 100-d transmitters later in the fall to increase the number of fish/transmitters active through the winter-spring season and spring migrations.

17) Attempt to inform the general public of ongoing telemetry studies in these drainages by signing at Forest information kiosks and where angling regulations are posted along the river.

APPENDIX A

Telemetry Metadata

Field Name	Heading/Data Form/ EXCEL File/Sheet	Description	Field Type	Field Width (no. char)
N/A	Radio Telemetry Surgery Form. C:/src_ysc_inventory/src_ysc_telemetry/documents/**telemetry_surgery_form.doc**	Field form used for radio transmitter implant surgery. Form contains information on species, photos, surgery locations, comments, etc.	N/A	N/A
N/A	Radio Telemetry Stream Location form. C:/ src_ysc_inventory/src_ysc_telemetry/documents/**radio_telemetry_field_data_form.doc**	Field form used for relocations of radio transmitter implanted fish. A form is completed for each fish and on every location attempt.	N/A	N/A
N/A	C:/src_ysc_inventory/src_ysc_telemetry/**src_ysc_telemetry_(*river*)_(*year)*/**transmitters/locations*.xls*	EXCEL data files are delineated by **river** drainage and ***year***. Includes data for individual fish implanted with radio transmitters within a ***river*** and for a specific transmitter-life beginning in the ***year***. Spreadsheets contain **ALL** collected on telemetry surgery forms and radio telemetry field data forms.	N/A	N/A
N/A	C:/src_ysc_inventory/src_ysc_telemetry/fish_movement_(***year)*.xls**	EXCEL data files are delineated by ***year***. Includes data for individual fish movements for each river drainage. Contains annual and seasonal movements, as well as migration movements along with transmitter life information.	N/A	N/A
t_freq	**Frequency –** Transmitter Implant Surgery form and Radio Telemetry Stream Location form. src_ysc_telemetry_(***river***)_(***year***)/transmitters/locations.xls fish_movement_(***year)***/all worksheets*.xls*	**Frequency** of the transmitter surgically implanted.	Number	7
stm_nam	**Stream Name –** Transmitter Implant Surgery form and Radio Telemetry Stream Location form. src_ysc_telemetry_(***river***)_(***year***)/transmitters/locations.xls	**Stream Name** as it appears on 7.5 minute (1:24,000) topographic map. The naming conventions are as follows: River (R), Creek (Cr), Fork (Fk), North (N), South (S), East (E), West (W), Middle (M). For example: Gros Ventre River (Gros Ventre R), West Fork of Goosewing Creek (Goosewing Cr, W Fk), North Fork of South Fork of Fish Creek (Fish Cr, N Fk S Fk). Unnamed streams and streams with same name within a river drainage are numbered sequentially as encountered moving upstream from the mouth of the mainstem stream first, than tributaries (unnamed1, etc.).	Character	20

subbasin	**Subbasin** – Transmitter Implant Surgery form and Radio Telemetry Stream Location form. src_ysc_telemetry_(***river***)_(***year***)/transmitters/locations.xls	Name of **subbasin** where stream is located is recorded as a two letter code where; **SH** = Snake Headwaters subbasin; **GV** = Gros Ventre subbasin; **GH** = Greys-Hoback subbasin; **PA** = Palisades subbasin; **SA** = Salt subbasin	Character	2
huc4	**Hydrologic Unit Code 8 Digit** - Fish Species Distribution Survey and Habitat Summary form; Stream Summary form; src_ysc_inventory_(***river***)/sample.xls	A unique **8-digit Hydrologic Unit Code** (HUC) for each ***subbasin*** from the USGS map series "Hydrologic Unit Maps". Also referred to as a ***4th field HUC***. The same **8-digit HUC** will be used for each stream sample record that pertains to a ***watershed*** or ***subwatershed*** that resides within the same **8-digit HUC**. ***Subbasin names*** are entered on Fish Species Distribution Survey and Habitat Summary form and Stream Summary form. The equivalent **8-digit HUC** is entered in src_ysc_inventory_(***river***)/sample.xls; Region **17** - Pacific Northwest Region; Subregion **1704** - Upper Snake; Basin - **170401** Snake Headwaters. Name of ***subbasin*** in which stream is located as follows: **Snake Headwaters = 17040101;** **Gros Ventre = 17040102;** **Greys-Hoback = 17040103;** **Palisades = 17040104;** **Salt = 17040105**.	Number	8
huc5	**Hydrologic Unit Code 10 Digit** – to be used in Subbasin assessments and Watershed analyses.	A unique **10-digit Hydrologic Unit Code** (HUC) for each ***watershed***. Also referred to as a ***5th field HUC***. Add two digits to the end of the existing **8-digit HUC**, therefore resulting in a **10-digit HUC** for each ***watershed*** within the respective ***subbasin***. This same **10-digit HUC** will be used for each stream sample record that pertains to a ***subwatershed*** that resides within the same **10-digit HUC**.	Number	10
huc6	**Hydrologic Unit Code 12 Digit** – to be used in Subbasin assessments and Watershed analyses.	A unique **12-digit Hydrologic Unit Code** (HUC) for each ***subwatershed***. Also referred to as a ***6th field HUC***. Add two digits to the end of the existing **10-digit HUC**, therefore resulting a **12-digit HUC** for each ***subwatershed*** within the respective ***watershed*** and ***subbasin***. This same **12-digit HUC** will be used for each stream sample record that pertains to a ***sub-subwatershed*** or ***reach*** that resides within the same **12-digit HUC**.	Number	12
date	**Date** – Transmitter Implant Surgery form and Radio Telemetry Stream Location form. src_ysc_telemetry_(***river***)_(***year***)/locations.xls	**Date** on which transmitter was implanted and relocations during field tracking. Entered as 3/14/1998 or 10/3/1998.	Date	9

t_life	**Life of Transmitter (d) –** Transmitter Implant Surgery form and Radio Telemetry Stream Location form. src_ysc_telemetry_(***river***)_(***year***)/transmitters.xls	The **Life of transmitter** guaranteed by manufacture, in **days,** that the transmitter will emit a signal. (e.g., 35, 100, or 283 days)**.**	Character	8
t_start	**Start Date –** Transmitter Implant Surgery Form. src_ysc_telemetry_(***river***)_(***year***)/transmitters.xls	**Date** transmitter switched on and implanted in fish. Entered as 3/14/1998 or 10/3/1998.	Date	8
t_cycle	**Transmitter Cycle** - Transmitter Implant Surgery form. src_ysc_telemetry_(***river***)_(***year***)/transmitters.xls	**Transmitter Cycle** refers to the number of days per week in which the transmitter is active (e.g., 35 and 100-day transmitters emit a **constant** signal daily. 283-day transmitters emit a signal from 0800-1800 h, MON – FRI).	Character	8
t_reach	**Start Reach -** Transmitter Implant Surgery form. src_ysc_telemetry_(***river)***_(***year***)/transmitters.xls	The **Reach** distance in which the fish was initially released on the transmitter **Start Date**. The reach number is the distance, in meters, from the streams mouth. **When available, reach distances are identified from distribution surveys.**	Number	5
f_loc_d	**Final location date** – Radio Telemetry Stream Location form. src_ysc_telemetry_(***river)***_(***year***)/transmitters.xls	The **Final location date** is last recorded field location for each transmitter. Entered as 3/14/1998 or 10/3/1998.	Date	8
spp_id	Species Identification – Transmitter Implant Surgery form. src_ysc_telemetry_(*river)*_(*year*)./transmitters.xls	Record the WGFD 3-letter **Species Identification** code (**See Appendix A**) under **Spp** on the Radio Transmitter Implant Surgery form, and **Comment** on unusual characteristics (i.e., SRC with larger spot size resembling YSC).	Character	3
length	**Total Length (mm)** – Transmitter Implant Surgery form. src_ysc_telemetry_(***river)***_(***year***)./transmitters.xls	Record the **Total Length** (TL) in **mm** of each fish implanted with a radio transmitter.	Number	3
weight	**Weight (gm)** – Transmitter Implant Surgery form. src_ysc_telemetry_(***river)***_(***year***)./transmitters.xls	Record the **Weight** (W), to the first decimal in **grams**, of each fish implanted with a radio transmitter on the Radio Transmitter Implant Surgery form. Weight is recorded to the nearest tenth	Number	5
pic_num	**Picture number** – Transmitter Implant Surgery form. src_ysc_telemetry_(***river)***_(***year***)./transmitters.xls	Photographs and fin clips are identified by a common alpha-Number code (**Picture number**) that includes the subbasin/year/film roll or digital camera/photograph# as follows: **SA** = Salt subbasin; **GH** = Greys-Hoback subbasin; **GV** = Gros Ventre subbasin; **SH** = Snake Headwaters subbasin; **PA** = Palisades; **98, 99, 00, 01, 02, 03** = year; **01, 02, 03** = film roll or digital camera; **1, 2, 3, …**k= sequential number of photograph of a film roll or during a sample year with a digital camera (e.g., the 25th fish	Character	20

		collected in the Greys-Hoback subbasin using camera #3 in 2002 is identified as **GH-02-03-25**).		
pic_ind	**Picture index** – src_ysc_telemetry_(***river)*** _(***year***)/transmitters.xls	Assigned **Picture index** values for film or digital photographs are completed in the spreadsheets only after photographs are reviewed, and deemed useful for species identification.	Character	6
w_temp	**Water temperature** – Radio Telemetry Stream Location form. Radio Telemetry Surgery Form. src_ysc_telemetry_(***river)*** _(***year***)/locations.xls	Record **Water temperature** to the first decimal (°**C**) at the release site **AND** each relocation site of a transmitter/fish. Temperature is recorded to the nearest tenth.	Number	4
time	**Time** – Radio Telemetry Stream Location form. Radio Telemetry Surgery Form. src_ysc_telemetry_(***river***) _(***year***)/locations.xls	Record the **Time** of release **OR** relocation of transmitter/fish in military hours. (1:00 PM = 1300 h)	Number	5
gps_file	**GPS File** - Transmitter Implant Surgery form and Radio Telemetry Stream Location form. src_ysc_telemetry_(***river***) _(***year***)/transmitters/locations.xls	Georeference location with **GPS** unit at point of release on the Transmitter Implant Surgery form, and habitat unit where transmitter/fish was relocated on the Radio Telemetry Stream Location form. Complete all entries in the data dictionary on the GPS unit, see GPS data dictionary.	Character	8
surg_com	**Surgery comments -** Transmitter Implant Surgery form. src_ysc_telemetry_(***river)*** _(***year***)./transmitters.xls	Comments made in field regarding **Surgery** procedures, site, or fish.	Character	75
r_loc	**Reach location (m)**- Radio Telemetry Stream Location form. src_ysc_telemetry_(***river***) _(***year***)/locations.xls	**Reach location** refers to the **reach distance** in which the fish and or transmitter was found for each location date. **When available, reach distances are identified from distribution surveys.** Reaches are recorded Numberally, such as 26000, 14000, and so forth.	Number	9
t_gain	**Gain –** Radio Telemetry Stream Location form. src_ysc_telemetry_(***river***) _(***year***)/locations.xls	**Gain** is taken from the receiver for each transmitter relocation. A low gain means that you are very close to the transmitter/fish. A gain of 0 usually means that you are within 1 m of the transmitter/fish.	Number	3
t_power	**Power –** Radio Telemetry Stream Location form. src_ysc_telemetry_(***river***) _(***year***)/locations.xls	**Power** is also recorded from the receiver. Power tells the strength of the signal received. A power of over 100 means that you have a very strong signal and very accurate reading. Power complements the gain in confirming a reading and location.	Number	3
mort	**Fish mortality –** Radio Telemetry Stream Location form. src_ysc_telemetry_(***river***) _(***year***)/locations.xls	Record whether a fish was confirmed alive or dead (**i.e., Fish mortality = N = alive; mort = Y = dead**; or **U** = unknown, no visual or movement confirmation). Effort shall be made during each relocation to visually confirm whether a fish alive **OR** disturb fish to induce a movement within the	Character	1

		habitat unit.		
mort_c	**Mortality cause** – Radio Telemetry Stream Location form. src_ysc_telemetry_(***river***)_(***year***)/locations.xls	Document **Mortality cause** in field and record under comments. Enter in EXCEL spreadsheet as: **A** = angler harvest; **P** = predator; or **U** = uncertain or unconfirmed cause of mortality.	Character	2
loc_com	**Comments** – Radio Telemetry Stream Location form. src_ysc_telemetry_(***river***)_(***year***)/locations.xls	**Comments** field describes in detail the location in which the transmitter/fish was found, or any other general comments about the transmitter, signal, or fish.	Character	76
tot_rang	**Total range (m)** – fish_movement_(***year)***/all worksheets.xls	**Total range** is the maximum upstream and downstream movement, in **meters**, exhibited by each fish for l**ife of transmitter**.	Number	5
tot_locs	**Total locations** – fish_movement_(***year)***/all worksheets.xls	**Total locations** is the sum of confirmed non-mortality relocations recorded for the l**ife of transmitter**.	Number	2
totd_act	**Total days active** – **fish_movement**_(***year)***/fish_cr_01/n_fk_fish_cr_01/l_greys_01/l_greys_02.*xls*	**Total days active** is the sum of days the transmitter was active from the transmitter implantation **start date** to the **final location date**.	Number	3
imp_jd	**Implant date on Julian Calendar** - fish_movement_(***year)***/all worksheets.xls	The **start date** based on Number days listed on the **Julian Calendar**.	Number	3
sf*n*_rang	**Summer-fall stream range (m)** - fish_movement_(***year)***/all worksheets.xls	The distance, in **meters**, between maximum upstream and downstream stream movement exhibited by each fish, in **meters**, for the ***n*th summer-fall season**; ***n*** = 1,2,3…k, for subsequent summer-fall seasons over the l**ife of transmitter**. The summer-fall season is identified as beginning after a fish has exhibited a spring migration; **OR** for fish where no migration was observed, the summer-fall season begins on the median Julian date of fish that exhibited a spring migration.	Number	5
sf*n*_locs	**Summer-fall locations** - fish_movement_(***year)***/all worksheets.xls	The number of **Summer-fall locations** recorded for each fish during the ***n*th** summer-fall season over the l**ife of transmitter**.	Number	2
sf*n*d_act	**Summer-fall days active** - fish_movement_(***year)***/all worksheets.xls	The number of **Summer-fall days active** for each transmitter during the ***n*th** summer-fall season over the l**ife of transmitter**. This is the difference between **Summer-fall Julian date from** and **to** during this season.	Number	3
sf*n*_jd_f	**Summer-fall Julian date from** - fish_movement_(***year)***/all worksheets.xls	The **Julian date** on which the first location was recorded for the ***n*th** summer-fall season over the l**ife of transmitter**.	Number	3
sf*n*_jd_t	**Summer-fall Julian date to** - fish_movement_(***year)***/all	The **Julian date** on which the last location was recorded for the ***n*th** summer-fall season over the l**ife of transmitter OR** the date in which a f**all**	Number	3

	worksheets.xls	**migration** movement occurred.		
sf*n*cum_m	**Summer-fall cumulative movement (m)** - fish_movement_(***year)***/all worksheets.xls	The **cumulative movement** (sum of up and downstream movements) the fish made, in **meters**, for the ***n*th** summer-fall season over the l**ife of transmitter**.	Number	5
sf*n*max_m	**Summer-fall maximum movement (m)** - fish_movement_(***year)***/all worksheets.xls	The single **maximum movement** for each fish, in **meters**, during the ***n*th** summer-fall season over the l**ife of transmitter**.	Number	5
sf*n*med_m	**Summer-fall median movement (m)** - fish_movement_(***year)***/all worksheets.xls	The **median movement**, in **meters**, for all movements made during the ***n*th** summer-fall season over the l**ife of transmitter**.	Number	4
f*n*_mig	**Fall migration (m)** – fish_movement_(***year)***/all worksheets.xls	The distance, in **meters**, of a **Fall migration** made by each fish during the ***n*th** fall season over the l**ife of transmitter**. A migration-movement must exceed the median movement observed for the summer-fall season, typically exceeds the maximum movement for the summer-fall season, and results in a movement beyond the observed up- or downstream summer-fall range.	Number	5
ws*n*_rang	**Winter-spring stream range (m)** - fish_movement_(***year)***/all worksheets.xls	The distance, in **meters**, between maximum upstream and downstream stream movement exhibited by each fish, in **meters**, for the ***n*th winter-spring season**; ***n*** = 1,2,3…k, for subsequent winter-spring seasons over the l**ife of transmitter**. The winter-spring season is identified as beginning after a fish has exhibited a fall migration; **OR** for fish where no migration was observed, the winter-spring season begins on the median Julian date of fish that exhibited a fall migration.	Number	5
ws*n*_locs	**Winter-spring locations** - fish_movement_(***year)***/all worksheets.xls	The number of **winter-spring locations** recorded for each fish during the ***n*th** winter-spring season over the l**ife of transmitter**.	Number	2
ws*n*d_act	**Winter-spring days active -** fish_movement_(***year)***/all worksheets.xls	The number of **winter-spring days active** for each transmitter during the ***n*th** winter-spring season over the l**ife of transmitter**. This is the difference between **winter-spring Julian date from** and **to** during this season.	Number	3
ws*n*_jd_f	**Winter-spring Julian date from** - fish_movement_(***year)***/all worksheets.xls	The **Julian date** on which the first location was recorded for the ***n*th** winter-spring season over the l**ife of transmitter**.	Number	3
ws*n*_jd_t	**Winter-spring Julian date to** - fish_movement_(***year)***/all worksheets.xls	The **Julian date** on which the last location was recorded for the ***n*th** winter-spring season over the l**ife of transmitter OR** the date in which a **spring migration** movement occurred.	Number	3
ws*n*cum_m	**Winter-spring cumulative movement (m)** -	The **cumulative movement** (sum of up and downstream movements) the fish made, in **meters**, for the ***n*th** winter-spring season over the l**ife of**	Number	5

	fish_movement_(***year)***/all worksheets.xls	**transmitter**.		
ws*n*max_m	**Winter-spring maximum movement (m)** - fish_movement_(***year)***/all worksheets.xls	The single **maximum movement** for each fish, in **meters**, during the ***n*th** winter-spring season over the l**ife of transmitter**.	Number	5
ws*n*med_m	**Winter-spring median movement (m)** - fish_movement_(***year)***/all worksheets.xls	The **median movement**, in **meters**, for all movements made during the ***n*th** winter-spring season over the l**ife of transmitter**.	Number	4
s*n*_mig1	**Spring Migration (m)** – fish_movement_(***year)***/all worksheets.xls	The distance, in **meters**, of a **Spring migration** made by each fish during the ***n*th** spring season over the l**ife of transmitter**. A migration-movement must exceed the median movement observed for the winter-spring season, typically exceeds the maximum movement for the winter-spring season, and results in a movement beyond the observed up- or downstream winter-spring range.	Number	5
s*n*_mig2	**Spring Migration (m)** – fish_movement_(***year)***/all worksheets.xls	The distance, in **meters**, of a ***second*** spring migration made by each fish during the ***n*th** spring season over the l**ife of transmitter**. Migration-movement must exceed the median movement observed for the winter-spring season, typically exceeds the maximum movement for the winter-spring season, and results in a movement beyond the observed up- or down-stream winter-spring range.	Number	5

APPENDIX B

Transmitter and Cutthroat Trout Data

Table 5. Total stream ranges occupied.

100-Day Transmitters			35-Day Transmitters			283-Day Transmitters		
Frequency	Stream Range (m)	Locations (no.)	Frequency	Stream Range (m)	Locations (no.)	Frequency	Stream Range (m)	Locations (no.)
150.003	350	17	150.233	400	15	150.515	0	1
150.013	200	12	150.262	300	14	150.525	0	2
150.021	1350	11	150.272	900	7	150.533	2800	22
150.032	1700	11	150.283	0	11	150.544	0	23
150.043	900	12	150.292	150	11	150.553	0	1
150.053	5000	4	150.302	0	13	150.565	1600	28
150.063	400	12	150.313	400	10	150.573	6000	6
150.072	200	17	150.324	400	10	150.585	0	12
150.083	1900	17	150.333		0	150.595	1300	19
150.093	400	11	150.342	330	14	150.605	400	22
150.103	150	12	150.353	0	12	150.614	0	1
150.114	1100	13	150.361	0	5	150.624	1300	27
150.123	200	11	150.371	300	11	150.635	7400	20
150.131	200	13	150.382	2500	7	150.644	0	1
150.144	400	14	150.393	150	10	150.655	0	1
150.153	200	16	150.402	400	12	150.675	100	5
150.161	4600	13	150.413	0	12	150.695	0	22
150.172	750	11	150.423	0	2			
150.183	450	17	150.432	1000	12			
150.191	100	14	150.443	0	2			
150.202	1500	15	150.453	0	2			
150.212	10	19	150.463	150	10			
150.222	700	13	150.473	975	13			
150.243	0	6	150.483	0	1			
			150.492	250	5			
			150.502	0	6			
mean	948	13	mean	344	9	mean	1229	12

Table 6. Total mortality.

Frequency	Stream	Transmitter Life (days)	Start Date	Final Location Date	Mortality Type[1]
150.053	L Greys R	100 days	07/18/01	08/17/01	a/p
150.093	L Greys R	100 days	07/18/01	10/12/01	p
150.123	L Greys R	100 days	07/18/01	10/14/01	p
150.172	L Greys R	100 days	07/18/01	10/12/01	p
150.283	L Greys R	35 days	07/18/01	10/14/01	u
150.525	L Greys R	283 days	07/17/01	08/11/01	u
150.544	L Greys R	283 days	07/17/01	06/14/02	u
150.553	L Greys R	283 days	07/17/01	08/03/01	u
150.573	L Greys R	283 days	07/18/01	09/14/01	p
150.605	L Greys R	283 days	07/19/01	06/14/02	u
150.635	L Greys R	283 days	07/20/01	06/14/02	p
150.675	L Greys R	283 days	07/20/01	09/07/01	a
150.695	L Greys R	283 days	07/19/01	06/20/02	u
150.595	Steer Cr	283 days	07/19/01	05/24/02	a/p
150.443	Fish Cr	35 days	07/25/01	08/08/01	a/p
150.453	Fish Cr	35 days	07/25/01	08/08/01	p
150.483	Fish Cr	35 days	07/25/01	08/01/01	a
150.515	Fish Cr	283 days	07/24/01	08/01/01	u
150.644	Fish Cr	283 days	07/25/01	08/01/01	a/p
150.655	Fish Cr	283 days	07/25/01	08/01/01	u
150.533	N Fk Fish Cr	283 days	07/23/01	08/12/02	u
150.614	N Fk Fish Cr	283 days	07/24/01	08/01/01	p
150.402	S Fk Fish Cr	35 days	07/24/01	10/15/01	p

[1] a – angling; p-predation; u – unconfirmed

Little Greys River and Steer Creek

Table 7. 35-d transmitters and fish metrics for the Little Greys River and Steer Creek.

Frequency	Cycle	Stream	Sub-Species	Length (mm)	Weight (gm)	Release Reach	Start Date	Final Location Date	Final Status
150.262	constant	L Greys R	YSC	352	450	26000	07/17/01	11/08/01	probable expiration
150.272	constant	L Greys R	SRC	332	340	26000	07/18/01	09/13/01	probable expiration
150.283	constant	L Greys R	SRC	340	365	24000	07/18/01	10/14/01	mortality
150.324	constant	L Greys R	SRC	369	490	14000	07/20/01	10/03/01	probable expiration
150.353	constant	L Greys R	SRC	375	510	20000	07/19/01	10/18/01	probable expiration
150.302	constant	Steer Cr	SRC	335	355	0	07/19/01	10/25/01	probable expiration
150.313	constant	Steer Cr	SRC	317	380	1000	07/19/01	10/03/01	probable expiration
150.333	constant	Steer Cr	SRC	340	440	0	07/19/01	not found	probable expiration
150.342	constant	Steer Cr	SRC	345	390	0	07/19/01	11/09/01	probable expiration

Table 8. Total movement of 340-510 gm cutthroat trout with 35-d transmitters, in the Little Greys River and Steer Creek during summer-fall 2001.

Frequency	Movement (m)	Locations (no.)	Days Active (no.)	Implant Date Julian
150.262	300	14	114	198
150.272	900	7	58	199
150.283	0	11	89	199
150.302	0	13	100	200
150.313	400	10	78	200
150.324	400	10	75	201
150.333		0		200
150.342	330	14	92	200
150.353	0	12	92	200
Mean	291	11	87	-

Table 9. Summer-fall 2001 movements of 340-510 gm cutthroat trout with 35-d transmitters, in the Little Greys River and Steer Creek.

Frequency	Summer -Fall Range (m)	Locations (no.)	Days Active (no.)	Julian Date From	Julian Date To	Cumulative Distance (m)	Maximum Distance (m)	Median Distance (m)	Migration Distance[1] (m)
150.262	100	11	69	216	285	100	100	0	0
150.272	900	7	41	215	256	900	900	0	0
150.283	0	11	71	216	287	0	0	0	0
150.302	0	11	70	215	285	0	0	0	0
150.313	400	10	61	215	276	800	400	0	0
150.324	400	10	60	216	276	800	250	50	0
150.342	50	12	75	216	291	50	50	0	280
150.353	0	12	76	215	291	0	0	0	0
Mean	231	10	65	-	-	331	213	-	280

[1] Mean only for those fish that exhibited a fall migration.

Table 10. Winter-spring 2002 movements of 340-510 gm cutthroat trout with 35-d transmitters, in the Little Greys River and Steer Creek.

Frequency	Winter-Spring Range (m)	Locations (no.)	Days Active (no.)	Julian Date From	Julian Date To	Cumulative Distance (m)	Maximum Distance (m)	Median Distance (m)	Migration Distance (m)
150.262	300	3	21	291	312	500	300	200	-
150.302	0	2	7	291	298	0	0	0	-
150.342	0	2	15	298	313	0	0	0	-
Mean	100	2	14	-	-	167	100	-	-

Table 11. 100-d transmitter and fish metrics for the Little Greys River and Steer Creek.

Frequency	Cycle	Stream	Sub-Species	Length (mm)	Weight (gm)	Release Reach	Start Date	Final Location Date	Final Status
150.003	constant	L Greys R	SRC	274	240	26000	07/17/01	03/22/02	probable expiration
150.053	constant	L Greys R	SRC	290	275	26000	07/18/01	08/17/01	mortality
150.072	constant	L Greys R	SRC	292	271	26000	07/17/01	03/22/02	probable expiration
150.083	constant	L Greys R	SRC	284	246	26000	07/17/01	03/22/02	probable expiration
150.093	constant	L Greys R	SRC	265	210	24000	07/18/01	10/12/01	mortality
150.123	constant	L Greys R	SRC	318	300	24000	07/18/01	10/14/01	mortality
150.153	constant	L Greys R	SRC	278	210	24000	07/18/01	02/21/02	probable expiration
150.161	constant	L Greys R	SRC	296	260	24000	07/18/01	10/26/01	probable expiration
150.172	constant	L Greys R	SRC	322	305	26000	07/18/01	10/12/01	mortality
150.191	constant	L Greys R	SRC	282	240	20000	07/19/01	11/09/01	probable expiration
150.212	constant	L Greys R	SRC	285	220	26000	07/18/01	05/03/02	probable expiration
150.233	constant	Steer Cr	YSC	293	320	0	07/19/01	11/09/01	probable expiration

Table 12. Total movement of 210-320 gm cutthroat trout with 100-d transmitters, in the Little Greys River and Steer Creek during summer-fall 2001 and winter-spring 2002.

Frequency	Movement (m)	Locations (no.)	Days Active (no.)	Implant Date Julian
150.003	350	17	249	198
150.053	5000	4	31	199
150.072	200	17	249	198
150.083	1900	17	249	198
150.093	400	11	87	199
150.123	200	11	89	199
150.153	200	16	219	199
150.161	4600	13	100	199
150.172	750	11	86	199
150.191	100	14	113	200
150.212	10	19	166	289
150.233	400	15	113	200
Mean	1,176	14	146	-

Table 13. Summer-fall 2001 movements of 210-320 gm cutthroat trout with 100-d transmitters, in the Little Greys River and Steer Creek.

Frequency	Summer-Fall Range (m)	Locations (no.)	Days Active (no.)	Julian Date From	Julian Date To	Cumulative Distance (m)	Maximum Distance (m)	Median Distance (m)	Migration Distance[1] (m)
150.003	200	11	70	215	285	300	200	0	0
150.053	5000	4	14	215	229	5000	5000	0	0
150.072	200	11	70	215	285	200	200	0	0
150.083	1000	13	83	215	298	1000	350	0	900
150.093	400	11	69	216	285	800	350	0	0
150.123	1600	11	60	216	276	200	200	0	0
150.153	200	11	96	216	312	400	200	0	0
150.161	4300	11	72	215	287	4700	4300	0	400
150.172	750	11	60	216	276	1000	550	0	0
150.191	100	11	70	215	285	100	50	0	0
150.212	0	11	70	215	285	0	0	0	0
150.233	150	11	69	216	285	150	150	0	250
Mean	1,158	11	67	-	-	1,154	963	-	517

[1] Mean only for those fish that exhibited a fall migration.

Table 14. Winter-spring 2002 movements of 210-320 gm cutthroat trout with 100-d transmitters, in the Little Greys River and Steer Creek.

Frequency	Winter-Spring Range (m)	Locations (no.)	Days Active (no.)	Julian Date From	Julian Date To	Cumulative Distance (m)	Maximum Distance (m)	Median Distance (m)	Migration Distance (m)
150.003	350	6	155	291	81	600	350	0	-
150.072	0	6	155	291	81	0	0	0	-
150.083	0	4	134	312	81	0	0	0	-
150.153	0	5	126	291	52	0	0	0	-
150.161	0	2	8	291	299	0	0	0	-
150.191	50	3	22	291	313	50	50	25	-
150.212	10	7	168	291	123	10	10	0	-
150.233	0	3	22	291	313	0	0	0	-
Mean	51	4	99	-	-	83	51	-	-

Table 15. 283-d transmitter and fish metrics for the Little Greys River and Steer Creek.

Frequency	Cycle	Stream	Sub-Species	Length (mm)	Weight (gm)	Release Reach	Start Date	Final Location Date	Final Status
150.525	F-T	L Greys R	SRC	392	570	26000	07/17/01	08/11/01	mortality
150.544	TH-M	L Greys R	SRC	440	690	26000	07/17/01	06/14/02	mortality
150.553	F-T	L Greys R	YSC	388	670	26000	07/17/01	08/03/01	mortality
150.565	W-S	L Greys R	SRC	387	590	24000	07/18/01	08/04/02	probable expiration
150.573	W-S	L Greys R	SRC	382	540	24000	07/18/01	09/14/01	mortality
150.605	W-S	L Greys R	SRC	373	540	1000	07/19/01	06/14/02	mortality
150.635	W-S	L Greys R	SRC	389	570	14000	07/20/01	06/14/02	mortality
150.675	W-S	L Greys R	SRC	371	590	14000	07/20/01	09/07/01	mortality
150.695	W-S	L Greys R	SRC	394	610	20000	07/19/01	06/20/02	mortality
150.595	W-S	Steer Cr	SRC	430	900	0	07/19/01	05/24/02	mortality

Table 16. Total movement of cutthroat trout 540-900 gm with 283-d transmitters, in the Little Greys River and Steer Creek from summer 2001 and summer 2002.

Frequency	Movement (m)	Locations (no.)	Days Active (no.)	Implant Date Julian
150.525	0	2	24	198
150.544	0	23	333	198
150.553	0	1	18	198
150.565	1600	28	383	199
150.573	6000	6	57	199
150.595	1300	19	310	200
150.605	400	22	331	200
150.635	7400	20	331	201
150.675	100	5	47	201
150.695	0	22	338	200
Mean	1680	15	217	-

Table 17. Summer-fall 2001 and summer 2002 movements of cutthroat trout 540-900 gm with 283-d transmitters, in the Little Greys River and Steer Creek.

Frequency	Summer-Fall Range (m)	Locations (no.)	Days Active (no.)	Julian Date From	Julian Date To	Cumulative Distance (m)	Maximum Distance (m)	Median Distance (m)	Migration Distance (m)
				Summer-Fall 2001					
150.525	0	2	8	215	223	0	0	0	0
150.544	0	11	69	216	285	0	0	0	0
150.553	0	1	1	215	215	0	0	0	0
150.565	50	11	69	216	285	50	50	0	0
150.573	6000	6	41	216	257	6000	6000	0	0
150.595	50	11	69	216	285	100	50	0	0
150.605	350	11	69	216	285	700	300	0	0
150.635	200	11	71	216	287	600	200	0	0
150.675	100	5	31	216	247	100	100	0	0
150.695	0	11	69	216	285	0	0	0	0
Mean	675	8	50	-	-	755	670	-	-
				Summer 2002					
150.565	200	9	127	89	216	400	200	0	-
150.595	0	1	1	144	144	0	0	0	-
150.635	0	2	8	157	165	0	0	0	-
Mean	67	4	45	-	-	133	67	-	-

Table 18. Winter-spring 2002 movements of cutthroat trout 540-900 gm with 283-d transmitters, in the Little Greys River and Steer Creek.

Frequency	Winter-Spring Range (m)	Locations (no.)	Days Active (no.)	Julian Date From	Julian Date To	Cumulative Distance (m)	Maximum Distance (m)	Median Distance (m)	Spring Migration Distance (m)	Spring[1] Migration Distance (m)
150.544	0	4	100	291	26	0	0	0	0	-
150.565	0	8	168	291	123	0	0	0	1400	1450
150.595	250	7	155	291	81	250	250	0	1050	1200
150.605	400	5	126	291	52	400	350	0	0	-
150.635	0	7	155	291	123	0	0	0	2400	4800
150.695	0	11	168	291	123	0	0	0	0	-
Mean	108	7	145	-	-	108	100	-		

[1] A second spring migration were observed only for cutthroat trout >540 gm with 283-d transmitters.

Fish Creek, North Fork Fish Creek, and South Fork Fish Creek

Table 19. 35-d transmitter and fish metrics for Fish Creek, North Fork Fish Creek, and South Fork Fish Creek.

Frequency	Cycle	Stream	Sub-Species	Length (mm)	Weight (gm)	Release Reach	Start Date	Final Location Date	Final Status
150.371	constant	Fish Cr	SRC	355	480	3000	07/24/01	10/11/01	probable expiration
150.382	constant	Fish Cr	SRC	350	340	3000	07/24/01	09/12/01	probable expiration
150.443	constant	Fish Cr	SRC	392	575	3000	07/25/01	08/08/01	mortality
150.453	constant	Fish Cr	SRC	324	390	3000	07/25/01	08/08/01	mortality
150.473	constant	Fish Cr	SRC	359	450	3000	07/25/01	10/31/01	probable expiration
150.483	constant	Fish Cr	SRC	333	370	3000	07/25/01	08/01/01	mortality
150.492	constant	Fish Cr	SRC	346	380	3000	07/25/01	08/27/01	probable expiration
150.502	constant	Fish Cr	SRC	361	390	3000	07/25/01	09/05/01	probable expiration
150.292	constant	N Fk Fish Cr	YSC	360	510	14000	07/23/01	10/10/01	probable expiration
150.361	constant	N Fk Fish Cr	SRC	355	480	12000	07/23/01	08/27/01	probable expiration
150.393	constant	N Fk Fish Cr	SRC	350	350	12000	07/23/01	10/01/01	probable expiration
150.463	constant	N Fk Fish Cr	SRC	365	440	14000	07/23/01	10/01/01	probable expiration
150.432	constant	N Fk Fish Cr	SRC	347	420	0	07/24/01	10/15/01	probable expiration
150.402	constant	S Fk Fish Cr	SRC	367	500	0	07/24/01	10/15/01	mortality
150.413	constant	S Fk Fish Cr	SRC	365	500	0	07/24/01	10/15/01	probable expiration
150.423	constant	S Fk Fish Cr	SRC	335	360	0	07/24/01	08/08/01	probable expiration

Table 20. Total movement of 340-510 gm cutthroat trout with 35-d transmitters, in Fish Creek, North Fork Fish Creek, and South Fork Fish Creek during summer-fall 2001.

Frequency	Movement (m)	Locations (no.)	Days Active (no.)	Implant Date Julian
150.292	150	11	79	204
150.361	0	5	35	204
150.393	150	10	70	204
150.463	150	10	70	204
150.371	300	11	79	205
150.382	2500	7	64	205
150.402	400	12	83	205
150.413	0	12	83	205
150.423	0	2	15	205
150.432	1000	12	83	205
150.443	0	2	14	206
150.453	0	2	14	206
150.473	975	13	98	206
150.483	0	1	7	206
150.492	250	5	33	206
150.502	0	6	42	206
Mean	367	8	54	-

Table 21. Summer-fall 2001 movements of 340-510 gm cutthroat trout with 35-d transmitters, in the Fish Creek, North Fork Fish Creek, and South Fork Fish Creek.

Frequency	Summer-Fall Range (m)	Locations (no.)	Days Active (no.)	Julian Date From	Julian Date To	Cumulative Distance (m)	Maximum Distance (m)	Median Distance (m)	Migration Distance[1] (m)
150.292	150	11	71	212	283	350	150	0	0
150.361	0	5	27	212	239	0	0	0	0
150.393	150	10	62	212	274	300	100	0	0
150.463	150	10	62	212	274	300	100	25	0
150.371	300	10	62	213	275	900	300	0	0
150.382	500	6	39	213	252	500	500	0	2000
150.402	400	10	62	213	275	400	400	0	0
150.413	0	10	62	213	275	0	0	0	0
150.423	0	2	7	213	220	0	0	0	0
150.432	350	11	71	213	284	950	350	0	1000
150.443	0	2	7	213	220	0	0	0	0
150.453	0	2	7	213	220	0	0	0	0
150.473	700	10	62	213	275	700	700	0	0
150.483	0	1	1	213	213	0	0	0	0
150.492	250	5	26	213	239	250	200	25	0
150.502	0	6	35	213	248	0	0	0	0
Mean	184	7	41	-	-	291	175	-	1,500

[1] Mean only for those fish that exhibited a fall migration.

Table 22. Winter-spring 2002 movements of 340-510 gm cutthroat trout with 35-d transmitters, in Fish Creek, North Fork Fish Creek, and South Fork Fish Creek.

Frequency	Winter-Spring Range (m)	Locations (no.)	Days Active (no.)	Julian Date From	Julian Date To	Cumulative Distance (m)	Maximum Distance (m)	Median Distance (m)	Migration Distance (m)
150.371	0	1	1	284	284	0	0	0	-
150.382	0	1	1	269	269	0	0	0	-
150.402	0	2	4	284	288	0	0	0	-
150.413	0	2	4	284	288	0	0	0	-
150.432	0	1	1	288	288	0	0	0	-
150.473	275	3	20	284	304	275	275	137	-
Mean	46	2	5	-	-	46	46	-	-

Table 23. 100-d transmitter and fish metrics for Fish Creek, North Fork Fish Creek, and South Fork Fish Creek.

Frequency	Cycle	Stream	Sub-Species	Length (mm)	Weight (gm)	Release Reach	Start Date	Final Location Date	Final Status
150.243	constant	Fish Cr	SRC	341	340	3000	07/25/01	10/31/01	probable expiration
150.013	constant	N Fk Fish Cr	SRC	315	319	14000	07/23/01	01/19/02	probable expiration
150.021	constant	N Fk Fish Cr	SRC	312	310	12000	07/23/01	10/10/01	probable expiration
150.032	constant	N Fk Fish Cr	SRC	282	220	12000	07/23/01	10/10/01	probable expiration
150.043	constant	N Fk Fish Cr	SRC	336	336	12000	07/23/01	01/24/02	probable expiration
150.063	constant	N Fk Fish Cr	SRC	305	310	12000	07/23/01	01/19/02	probable expiration
150.103	constant	N Fk Fish Cr	SRC	284	220	12000	07/23/01	01/19/02	probable expiration
150.114	constant	N Fk Fish Cr	SRC	321	280	12000	07/23/01	02/19/02	probable expiration
150.131	constant	N Fk Fish Cr	SRC	326	330	20000	07/23/01	02/19/02	probable expiration
150.144	constant	N Fk Fish Cr	SRC	295	250	20000	07/23/01	03/26/02	probable expiration
150.183	constant	N Fk Fish Cr	SRC	282	270	0	07/24/01	05/06/02	probable expiration
150.202	constant	S Fk Fish Cr	SRC	292	225	0	07/24/01	03/26/02	probable expiration
150.222	constant	S Fk Fish Cr	SRC	304	250	0	07/24/01	10/31/01	probable expiration

Table 24. Total movement of 220-340 gm cutthroat trout with 100-d transmitters, in Fish Creek, North Fork Fish Creek, and South Fork Fish Creek during summer-fall 2001.

Frequency	Movement (m)	Locations (no.)	Days Active (no.)	Implant Date Julian
150.013	200	12	180	204
150.021	1350	11	79	204
150.032	1700	11	79	204
150.043	900	12	180	204
150.063	400	12	180	204
150.103	150	12	180	204
150.114	1100	13	211	204
150.131	200	13	211	204
150.144	400	14	238	204
150.183	450	17	316	205
150.202	1500	15	245	205
150.222	700	13	99	205
150.243	0	6	99	206
Mean	696	12	177	-

Table 25. Summer-fall 2001 movements of 220-340 gm cutthroat trout with 100-d transmitters, in the Fish Creek, North Fork Fish Creek, and South Fork Fish Creek.

Frequency	Summer-Fall Range (m)	Locations (no.)	Days Active (no.)	Julian Date From	Julian Date To	Cumulative Distance (m)	Maximum Distance (m)	Median Distance (m)	Migration Distance[1] (m)
150.013	200	11	70	212	282	600	200	50	0
150.021	100	7	42	212	254	100	100	0	1000
150.032	400	7	42	212	254	400	0	0	1300
150.043	600	11	71	212	283	1250	400	25	800
150.063	200	11	71	212	283	400	150	50	350
150.103	150	11	71	212	283	350	150	0	0
150.114	1100	11	71	212	283	2800	1100	25	0
150.131	100	11	70	212	282	150	50	0	200
150.144	400	11	71	212	283	850	400	0	0
150.183	275	10	62	213	275	275	200	0	0
150.202	0	10	62	213	275	0	0	0	1500
150.222	700	10	62	213	275	700	700	0	0
150.243	0	3	14	261	275	0	0	0	0
Mean	325	10	60	-	-	606	265	-	858

[1] Mean only for those fish that exhibited a fall migration.

Table 26. Winter-spring 2002 movements of 220-340 gm cutthroat trout with 100-d transmitters, in Fish Creek, North Fork Fish Creek, and South Fork Fish Creek.

Frequency	Winter-Spring Range (m)	Locations (no.)	Days Active (no.)	Julian Date From	Julian Date To	Cumulative Distance (m)	Maximum Distance (m)	Median Distance (m)	Migration Distance (m)
150.013	0	1	1	19	19	0	0	0	-
150.021	250	4	23	260	283	550	250	200	-
150.032	800	4	23	260	283	800	800	0	-
150.043	0	1	1	24	24	0	0	0	-
150.063	0	1	1	19	19	0	0	0	-
150.103	0	1	1	19	19	0	0	0	-
150.114	330	2	31	19	50	330	330	0	-
150.131	0	2	31	19	50	0	0	0	-
150.144	0	3	66	19	85	0	0	0	0
150.183	450	7	166	284	126	725	250	100	0
150.202	0	5	162	288	85	0	0	0	0
150.222	0	3	20	284	304	0	0	0	-
150.243	0	3	20	284	304	0	0	0	-
Mean	141	3	42	-	-	185	125	-	-

Table 27. 283-d transmitter and fish metrics for Fish Creek, North Fork Fish Creek, and South Fork Fish Creek.

Frequency	Cycle	Stream	Sub-Species	Length (mm)	Weight (gm)	Release Reach	Start Date	Final Location Date	Final Status
150.515	M-F	Fish Cr	SRC	385	620	3,000	07/24/01	08/01/01	mortality
150.644	M-F	Fish Cr	SRC	380	560	3,000	07/25/01	08/01/01	mortality
150.655	M-F	Fish Cr	SRC	439	750	3,000	07/25/01	08/01/01	mortality
150.533	M-F	N Fk Fish Cr	SRC	319	540	12,000	07/23/01	08/12/02	mortality
150.585	M-F	N Fk Fish Cr	SRC	342	660	0	07/24/01	05/17/02	probable expiration
150.614	M-F	N Fk Fish Cr	SRC	403	630	0	07/24/01	08/01/01	mortality
150.624	M-F	S Fk Fish Cr	SRC	387	600	0	07/24/01	07/30/02	probable expiration

Table 28. Total movement of 540-750 gm cutthroat trout with 283-d transmitters, in Fish Creek, North Fork Fish Creek, and South Fork Fish Creek during summer-fall 2001.

Frequency	Movement (m)	Locations (no.)	Days Active (no.)	Implant Date Julian
150.533	2,800	22	373	204
150.515	0	1	8	206
150.585	0	12	297	205
150.614	0	1	8	205
150.624	1,300	27	376	205
150.644	0	1	7	206
150.655	0	1	7	206
Mean	586	9	154	-

Table 29. Summer-fall 2001 and summer 2002 movements of cutthroat trout 540-750 gm with 283-d transmitters, in Fish Creek, North Fork Fish Creek, and South Fork Fish Creek.

Frequency	Summer-Fall Range (m)	Locations (no.)	Days Active (no.)	Julian Date From	Julian Date To	Cumulative Distance (m)	Maximum Distance (m)	Median Distance (m)	Migration Distance (m)
				Summer-Fall 2001					
150.533	900	11	71	212	283	3,100	900	50	0
150.515	0	1	1	213	213	0	0	0	0
150.585	0	8	62	213	275	0	0	0	0
150.614	0	1	1	213	213	0	0	0	0
150.624	0	10	62	213	275	0	0	0	0
150.644	0	1	1	213	213	0	0	0	0
150.655	0	1	1	213	213	0	0	0	0
Mean	129	5	28	-	-	443	129	-	-
				Summer 2002					
150.533	450	7	67	157	224	450	450	0	-
150.624	200	7	47	164	211	200	200	0	-
Mean	325	7	57	-	-	325	325	-	-

Table 30. Winter-spring 2002 movements of 540-750 gm cutthroat trout with 283-d transmitters, in Fish Creek, North Fork Fish Creek, and South Fork Fish Creek.

Frequency	Winter-Spring Range (m)	Locations (no.)	Days Active (no.)	Julian Date From	Julian Date To	Cumulative Distance (m)	Maximum Distance (m)	Median Distance (m)	Spring Migration Distance (m)	Spring Migration Distance (m)
150.533	500	4	266	284	185	600	500	250	1,000	1,400
150.585	0	4	218	284	137	0	0	0	0	-
150.624	200	10	238	284	157	200	200	0	1,000	1,300
Mean	233	6	241	-	-	267	233	-	1,000	1,350